The Australian and New Zealand
JOURNAL OF SURGERY

Vol. XIX — No. 4 MAY, 1950

PULMONARY HYDATID DISEASE.

A REVIEW OF 478 CASES REPORTED IN THE LOUIS BARNETT HYDATID REGISTRY OF THE ROYAL AUSTRALASIAN COLLEGE OF SURGEONS.

By NORMAN WADDLE
Dunedin.

WITH the rapid progress made in recent years in the development of thoracic surgery there has been a resurgence of interest in, and discussion of, the management of cases presenting with hydatid cysts in the lungs. This is exemplified by the numerous articles by various writers all over the world which have appeared in different surgical journals during the last two years. These papers have dealt chiefly with methods of treatment, and it is apparent that considerable diversity of opinion upon the details of management of these cases still exists. From the variety of complicating factors under which pulmonary hydatid disease may present itself, it seems probable that standardization of operative procedure is impossible of achievement. Perhaps it is wrong to seek to standardize methods, because of this variation in particular circumstances, which demands selective measures of treatment to achieve successful results. Principles of treatment remain stable; methods must be adapted and modified according to particular conditions which vary with individual cases.

This review, based upon the clinical records of 478 cases of pulmonary hydatid disease, aims to survey the surgical problem as a whole and to evaluate, as far as possible, the results of treatment.

The record of cases extends over a period of nearly thirty years and comprises all the notified cases of pulmonary hydatid disease which have come under observation and treatment during that time in New Zealand and Australia. Since notification is not compulsory, and since it is well recognised that some cases may escape medical observation, it is not to be assumed that these 478 cases represent the actual incidence of pulmonary hydatid disease in these two countries. The number of cases of pulmonary hydatids recorded in each decade since the inception of the Register shows that, although hydatid disease is readily preventable and could be entirely eradicated by relatively simple measures well known to Public Health Authorities, it continues to be endemic in farming countries with no evidence of diminution (Fig. I.).

The falling off of new registrations during the last seven years in New Zealand cannot be attributed to any lessening of the incidence of hydatid disease; it is more probably due to the disruption of notifications during the war years.

Figs. II A and II B show, graphically, the decades of life during which hydatid infestation of the lungs becomes clinically manifest. The total numbers of cases for each age group (green) are subdivided to show the sex incidence female (blue) and male (red).

It will be noted that males are affected more often than females and also that most cases develop first symptoms between the ages of 20 and 30 years. The decades preceding and following this age group are surprisingly approximate as regards total numbers.

Fig. I.

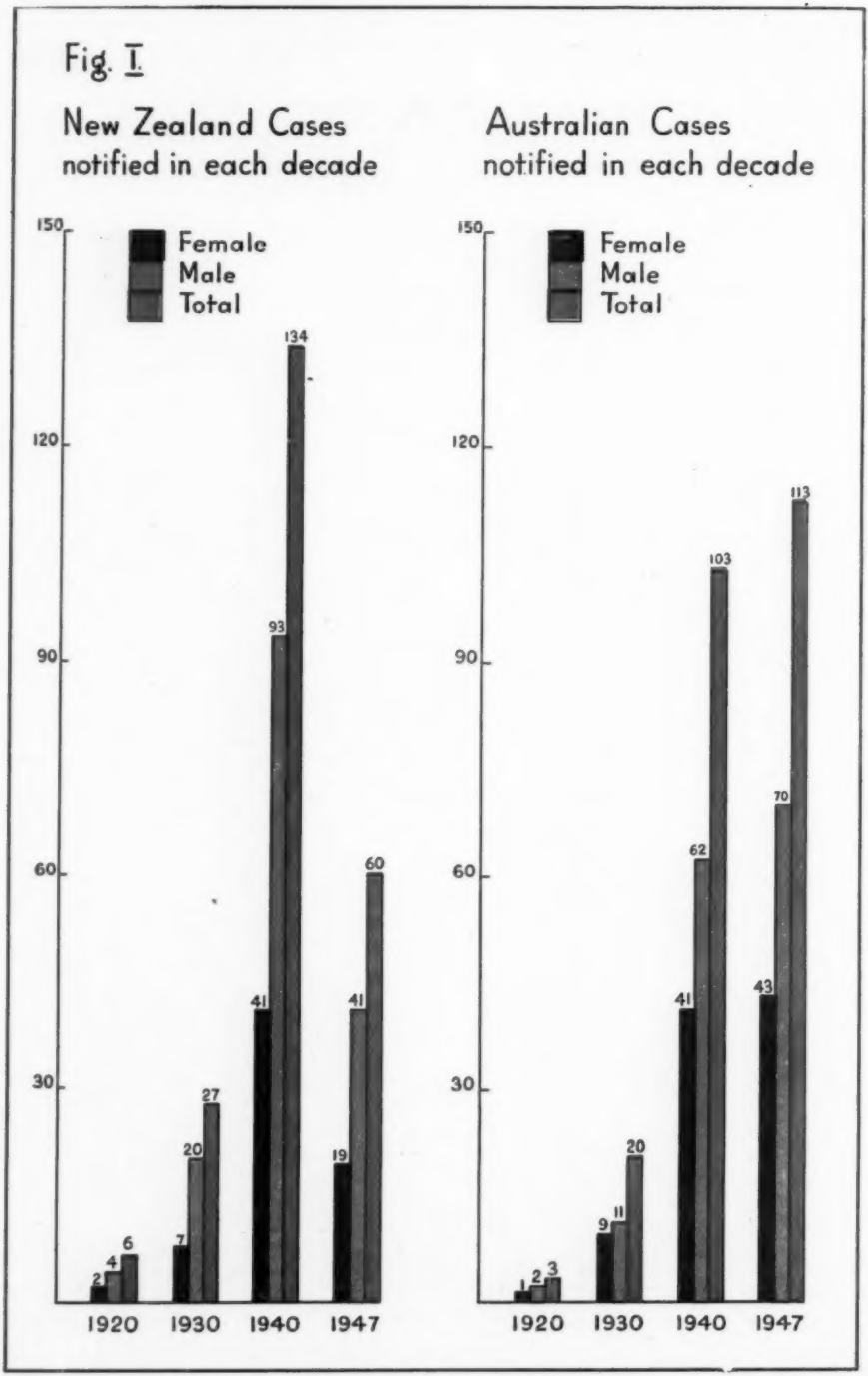

New Zealand Cases
notified in each decade
Female
Male
Total
150
120
90
60
30
2
4
6
7
20
27
41
93
134
19
41
60
1920
1930
1940
1947
Australian Cases
notified in each decade
Female
Male
Total
150
120
90
60
30
1
2
3
9
11
20
41
62
103
43
70
113
1920
1930
1940
1947

Fig. II. (A)

Pulmonary Hydatid Infestation
Series of 246 Australian Cases

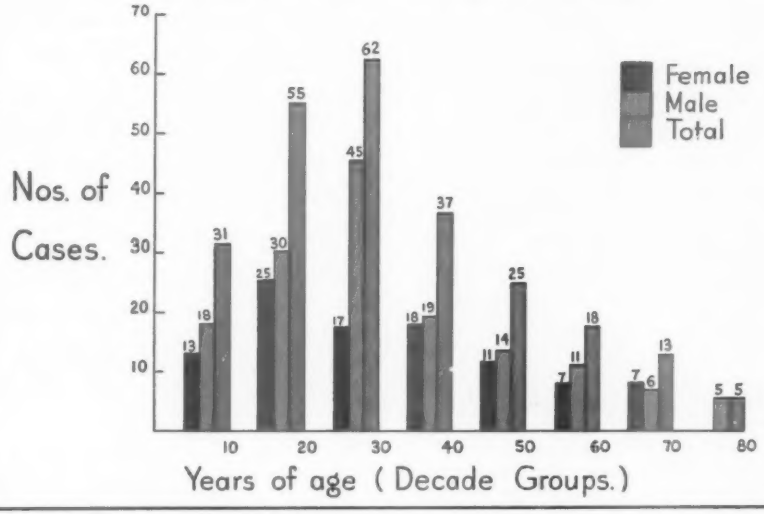
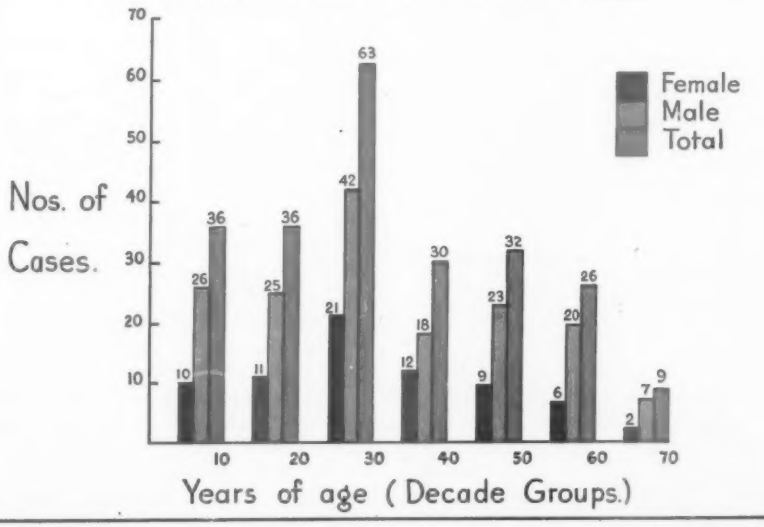


Fig. II. (B)

Pulmonary Hydatid Infestation
Series of 232 New Zealand Cases



The preponderance of males over females affected is due most likely to the fact that dogs, from which the hydatid ova come, are, for the most part, working dogs in sheep country with which the male members of the community are in closer association than the female members.

The highest incidence of manifest hydatid disease during the 20 - 30 age group, corresponds closely to the figures for the incidence of hydatid disease in the Argentine Republic. No particular inference can be derived from this finding because the hydatid cyst is known to grow very slowly over a period of years, and we have no means of calculating the age of a cyst from its size or appearance. The age of the host, at the time clinical symptoms appear, gives no reliable indication of the age at which infestation first occurred. It is generally acknowledged that, in conformity with other parasitic infestations, hydatid embryos find their most likely hosts amongst children. Probably because social care and cleanliness are still in the process of being inculcated in children, and because there is also a natural inclination amongst children to fondle the dogs with which they play, the liability to ingestion of hydatid ova is maximal at this period of life. However, infection may occur during adult years where there is a close association with infested dogs, and this must be the case where symptoms present themselves in the later age groups.

This point is illustrated by Case 2047:

G.M., aged 26, had lived and worked on farms all his life. In 1942 he joined the Army and was graded A1, and routine X-ray examination of the chest in July, 1942, showed normal lung fields.

In 1945, after having served abroad in Egypt and Italy for three years, he presented for discharge from the Army. He was quite fit and had no symptoms of any kind. Routine X-ray examination of the chest in October, 1945, showed a typical hydatid cyst of the right lung in its middle lobe. The diameter of the cyst was 3 inches. There was no evidence of hydatid cysts in any other viscus.

The inference to be drawn is that infestation had occurred in adult life not long before he joined the army and that the lesion was then too small to be demonstrable by X-ray examination, but that it had grown to 3 inches in diameter during the ensuing three years.

The rate of growth of hydatid cysts in the lung is well illustrated by Case 2046:

A.W., female, aged 10, was examined in 1942, when X-ray films showed three lung cysts, one in the right upper lobe, one in the right lower lobe, and one in the left lower lobe. Two hydatid cysts in the liver were removed surgically in 1946, but the lung cysts were all coughed up at varying intervals of time after their first detection.

(a) The right upper cyst ruptured when it was 5 inches x 3½ inches, having increased from 2 inches x 1½ inches in twenty-one months.

(b) The right lower cyst ruptured when it was 5 inches x 5 inches, having increased from 2 inches x 1½ inches in twenty-three months.

(c) The cyst in the left lower lobe ruptured when it was 3 inches in diameter, having increased from 2 inches in six months.

By contrast, one of the cysts in the liver had grown more slowly, taking three years to reach a diameter of three inches, when it was removed surgically. When first observed, all these cysts were similar in size, a finding suggestive of a severe multiple primary infestation.

These two cases confirm the accepted view that hydatid cysts achieve their greatest rapidity of growth in children and that rate of growth varies according to the nature of the organ in which the cyst develops, as well as being influenced by local variations in nutrition and by variations in the natural resistance of the host's tissues.

PRIMARY AND SECONDARY LUNG CYSTS.

In this series of cases relatively very few (approximately 10 per cent) are recorded as having liver cysts present also. How far one is justified in assuming from this that the great majority of hydatid cysts in the lung are primary, I hesitate to suggest, but it would appear that, although pulmonary cysts are less common than those in the liver, nevertheless when lung cysts are present, the common experience is that the lung lesion is the only one present, although not invariably so. This raises the question whether the liver capillaries invariably serve as the "first hydatid filter," which is the commonly accepted view. No final answer can be given to this debatable point. Dévé of Rouen (1916) showed experimentally that hydatid embryos sometimes entered lacteals and that mediastinal lymph nodes became the site of primary cysts.

From this it would seem possible that the abdominal lymphatics and the thoracic duct may provide a route to the lungs which bypasses the portal venous system and liver. This would account for primary pulmonary cysts occurring as the only site of lodgement in the host.

DIAGNOSIS.

Since there is a long latent period, often to be measured in years, between the time of infestation and the first appearance of any symptom, the early recognition of a hydatid cyst must remain purely a fortuitous discovery by X-ray examination of the chest performed for some other reason. In this series of cases only 6.4 per cent of the total were so discovered in the X-ray procedures carried out by military authorities.

That this should be so, is a striking commentary upon the high degree of biological adaptation achieved by the hydatid parasite, representing an advanced stage of evolution not enjoyed by many other parasites affecting human beings. The insidious invasion of the host, lacking demonstrable reactive symptoms, at once guarantees the survival of the hydatid species and confounds all attempts to diagnose its presence.

In fact, the presence of a hydatid cyst becomes a suspected possibility only when some untoward event occurs in the immediate environment of the cyst such as to threaten its survival — leakage, frank rupture, or bacterial infection. Any or all of these mishaps to the parasite are most liable to occur to a cyst in the lung for obvious anatomical reasons, so that such clinical symptoms as occur are the result of one or other of these complicating "accidents" to the parasite.

Such being the case, the presenting symptoms are not pathognomonic of hydatid disease *per se*, and in their protean and rather vague character often closely mimic other more common diseases of the lungs.

Table 1 gives, in order and percentage of frequency, the presenting symptoms which can result from hydatid disease of the lung. One or more of these, in almost infinite variety of combination, can occur in any given case. Because recurrence or persistence of these symptoms over a long period of time is the invariable rule, it is obvious why pulmonary tuberculosis is so commonly diagnosed in error and why so many of these patients have, in the past, spent some time in sanatoria.

TABLE I.

SYMPTOMATOLOGY IN PULMONARY HYDATIDS.

New Zealand Cases		Australian Cases	
(1) Cough	80%	(1) Cough	72.8%
(2) Pain	58%	(2) Pain	46.9%
(3) Sputum	50%	(3) Sputum	47.3%
(4) Haemoptysis	47%	(4) Haemoptysis	50.6%
(5) Pleurisy	26.7%	(5) Pleurisy	16.4%
(6) Dyspnoea	24.5%	(6) Dyspnoea	23%
(7) Vomica	12.5%	(7) Vomica	16.4%
(8) Empyema	2.6%	(8) Empyema	2.9%
(9) Hydro-pneumothorax	—	(9) Hydro-pneumothorax	2.4%
(10) Latent	6.4%	(10) Latent	9%

Bronchiectasis, pulmonary abscess (from causes other than ruptured hydatid cyst) and even bronchogenic carcinoma also enter into the differential diagnosis.

Clinical examination alone does not usually elucidate the diagnosis, unless, as occasionally occurs, there is a local bulging of the chest wall which presents an unmistakable fluid thrill. The more usual signs, if there be any at all, are non-specific and comprise those commonly associated with atelectatic lung or a pleural effusion. Herein lies a danger, for unless the possibility of hydatid disease is remembered, the temptation to use an aspirating needle for diagnostic purposes is very great. This error has occurred in many of the recorded cases and invariably has produced severe and even dangerous complications, not the least of which has been anaphylactic shock. It cannot be stressed too strongly, nor the knowledge too widely disseminated, that needle aspiration of a suspected hydatid cyst must never be done except in the course of an operation properly planned and with adequate safeguards against spilling. In contrast to the foregoing, a small number of cases present themselves dramatically, with catastrophic suddenness. These are usually young vigorous adults in whom some slight accident or unusual physical effort has caused a sudden rise of intrathoracic pressure, resulting in the rupture of a previously unsuspected cyst. This is followed by either a copious haemoptysis or

a flooding of the bronchial tree by the large quantities of hydatid fluid, with concomitant asphyxia. Exceptionally, spontaneous haemopneumothorax may arise in this way from the sudden rupture of a pulmonary hydatid cyst. It is in this type of case that an urticarial skin rash most commonly occurs as the result of massive absorption of a large amount of hydatid fluid.

In all cases, except the last-mentioned type, differential diagnosis from other pulmonary diseases depends upon two lines of investigation:

1. Specific tests, including the presence of eosinophilia.
2. Interpretation of X-ray films, including bronchograms.

The eosinophilia, which is the usual response to parasitic infestation, is, in the case of hydatid disease of the lung, so unreliable as to be completely valueless as a diagnostic aid. In this series of cases eosinophilia in the circulating blood was so seldom found, or else of such negligible proportions, as to suggest that any reaction by the host had failed to occur at all. Alternatively, such initial response as there may have been had subsided with the development of toleration of the parasite by the host's tissues. Eosinophilia tends to be a finding most constantly observed soon after the surgical removal of a cyst or after its spontaneous rupture, and not before. The results of the Casoni skin test and the hydatid complement fixation tests are shown in Tables 2 and 3.

TABLE 2.

EVALUATION OF THE CASONI TEST AND THE HYDATID COMPLEMENT FIXATION TEST.

(Australian Cases)

Neither Test done	CASONI alone	H.C.F. alone	Combined	Combined Negative	Cas. Pos. H.C.F. Neg.	Cas. Neg. H.C.F. Pos.	Total Cases
73	43 Pos. 32 Neg.	2 Pos. 1 Neg.	Positive 35	23	20	18	247

CASONI TEST gave a positive result in 57.3% of proven Australian cases.

HYDATID COMPLEMENT FIXATION TEST gave positive results in 55.5% of proven Australian cases. Where both tests were combined, positive results were obtained in 76% of proven cases, in the following proportions:—

Both tests positive 36%
Casoni Pos., H.C.F. Neg. 20.8%
H.C.F. Pos., Casoni Neg. 18.7%

TABLE 3.

EVALUATION OF THE CASONI TEST AND THE HYDATID COMPLEMENT FIXATION TEST.

(New Zealand Cases)

Neither Test done	CASONI alone	H.C.F. alone	Combined Positive	Combined Negative	Cas. Pos. H.C.F. Neg.	Cas. Neg. H.C.F. Pos.	Total Cases
49	40 Pos. 10 Neg.	11 Pos. 6 Neg.	42	33	30	10	231

CASONI TEST gave positive results in 68% of proven cases.

HYDATID COMPLEMENT FIXATION TEST gave positive results in 48% of proven cases. Where both tests were carried out, positive results were obtained in 71% of proven cases, in the following proportions:—

Both tests positive 36%
Casoni Pos., H.C.F. Neg. 26%
H.C.F. Pos., Casoni Neg. 9%

This analysis shows a close approximation in the results obtained both in Australia and in New Zealand, and further demonstrates that positive results cannot be expected in more than approximately 70 per cent of cases where both tests are performed. Negative results with both are to be expected in 30 per cent of cases, so that a negative result does not exclude the diagnosis of hydatid disease.

The reason for the extreme variability in the results obtained from these tests and the consequent unreliability of negative findings seems to depend upon the fact that the ectocyst behaves as a semi-permeable membrane absorbing nourishment from the host's tissues, but allowing no egress of hydatid fluid unless some damage to the ectocyst wall occurs to permit leakage. From the nature of both tests it follows that neither will show positive results unless there has been leakage of hydatid fluid into the host's tissues.

The Casoni test depends upon sensitization of the tissues by small doses of hydatid protein elements and is therefore in the nature of an anaphylactic phenomenon. On the other hand, the hydatid complement fixation is a test for specific antibodies in the host's blood and is therefore a quantitative measure of the amount of antigen (hydatid fluid) which has recently been absorbed by the host. If there has been no recent absorption, as in the case of an intact cyst or in the case of a ruptured cyst which has free external drainage, this test will be negative.

This is probably an over simplification of the immunological reactions, but gives a working conception of the reasons for the possible variation in results obtained from tests. As Dew (1928) pointed out, the antigenic properties of any given sample of hydatid fluid are extremely variable and the reaction to it is probably far more complex than the foregoing explanation would indicate.

It is abundantly proved from the records under review that X-ray films of the chest are necessary for the diagnosis of pulmonary hydatid cysts as well as being of supreme importance in the pre-operative orientation of the cyst within the lung substance. The demonstration of its relationship to main bronchi and to the surface of the lung gives invaluable information to the surgeon. There are many pitfalls in the interpretation of films and numerous articles have been written on the bizarre appearances peculiar to hydatid cysts in X-ray films: "Sign of the Camelot," "Cumbo's Sign" and others. The chief points are that antero-posterior, lateral and oblique views should be available in order to exploit to its full advantage this pre-eminently valuable method of diagnosis and localization. Even when all this is done, there will still remain the occasional case where complicating factors obscure the diagnosis in spite of every precaution, but such cases are becoming noticeably fewer with improved technique in radiology and greater experience in the interpretation of chest films. Preliminary induction of pneumothorax as an aid to X-ray investigation is to be condemned as dangerous, since intrapleural rupture of the cyst may, thereby, be caused.

LOCATION OF LUNG CYSTS AND INCIDENCE OF DAUGHTER CYSTS.

It has been stated (Philips et al., 1949) that hydatid cysts occur more frequently in the right lung than in the left. Tables 4 and 5 give the percentage of cysts relative to each lung and serve to confirm the fact that the right lung is more commonly affected than the left.

TABLE 4.

SURGICAL PATHOLOGY IN PULMONARY HYDATIDS.

(Series of 244 Australian Cases)

Incidence		Presence of Daughter Cysts	
Cyst in Right Lung	56.4%	Not recorded present or absent	70%
Cyst in Left Lung	37%	Recorded as absent	22.5%
Cysts in both Lungs	6.6%	Recorded as present	7.4%

TABLE 5.

SURGICAL PATHOLOGY IN PULMONARY HYDATIDS.

(Series of 232 New Zealand Cases)

Incidence		Presence of Daughter Cysts	
Cyst in Right Lung	51.3%	Not recorded present or absent	49%
Cyst in Left Lung	39.3%	Recorded as absent	40%
Cysts in both Lungs	9.3%	Recorded as present	11%

The suggestion that this is because the course of the right pulmonary artery is rather more direct than is that of the left, is probably as good as any other hypothesis.

The Registry records do not differentiate the position of the cysts into peripheral and hilar (or parenchymatous), so that no relative figures can be given on this matter. It would appear that most surgeons regard this classification as being academic rather than practical, since no particular mention is made of it in this large series of case notes.

Similarly, there is a noticeable lack of specific statement about the presence or absence of daughter cysts in the pulmonary cases. The relative percentages are set out in Tables 4 and 5. Assuming that "no record" means that daughter cysts were absent, one can infer that daughter cyst formation is an uncommon event in lung cysts because only about 10 per cent of cases presented this feature.

MANAGEMENT AND TREATMENT.

No systemic treatment has yet been discovered whereby the parasite may be destroyed within its host. Although the records show that a great many victims achieve a cure by coughing up the cyst after it has ruptured, the risks of serious and even dangerous illness are so great as to demand some safer method of eradicating the parasite. In the present state of our knowledge such methods can only be surgical.

The total elimination of the cyst without spilling any of its contents is the objective to be sought. To achieve this is seldom, if ever, easy and the difficulties arise from two sources:—

1. From the host they arise from the anatomical and physiological problems associated with the pleural cavity; the situation of the cyst within the lung; the possibility of bronchial fistula and the complicating factor of sepsis associated with ruptured cysts.
2. From the hydatid cyst they arise because of the tense pressure of the fluid contents of an unruptured cyst, enclosed by the relatively thin friable ectocyst. This renders its intact removal impossible and, on the other hand, preliminary drainage risks spilling of the contents with inevitable seeding of scolices and multiple recurrences.

The records of cases in the Registry give many instances of near catastrophes having arisen from each of these causes separately or together.

The principles which have been evolved in the management of the cyst once it has been exposed at operation are now fairly well standardized and are:—

1. The whole area of approach from skin surface down to the cyst wall must be thoroughly protected with swabs or packing gauze, as meticulously as if an abscess cavity were about to be opened.
2. Only after this has been done may the cyst be punctured to aspirate some of its contents so as to reduce the tension in order to lessen the risk of its bursting with explosive violence. To do this without leakage, it is necessary to use a very fine needle, and a "suction bell" designed by Fitzpatrick (1945) is an added protection against spilling.

The swabs and packing gauze used to protect the wound surfaces are commonly wrung out in weak formalin solution (2 per cent) as an additional precaution, and the idea that it is necessary to inject formalin solution into the decompressed cyst after aspiration still lingers as a tradition with some surgeons. Many are still doing this to

cysts in the lung, and there are several records of severe complications resulting from this practice, due to formalin solution escaping through a fistula into the bronchi and causing severe irritation with partial asphyxiation of the patient. For this reason, informed opinion now condemns the use of formalin solution for injecting into lung cysts. I, personally, am sceptical about the use of formalin as a surgical aid in dealing with hydatid cysts generally, since its use as an antiseptic in surgery seems to be limited traditionally to this one condition. The reason why it is advocated is something of a mystery, because formalin is non-specific in its action of coagulating proteins. How long it takes for any given strength of formalin solution to kill hydatid elements is quite unknown, since hydatids cannot be grown apart from their natural habitat of living tissue. As far as I can discover, it has yet to be proved that formalin is more lethal to hydatid scolices than to the host's tissues or that it is superior in the purpose for which it is used to other less irritating antiseptics.

The problems associated with the pleural cavity in the removal of a hydatid cyst of the lung continue to vex the ingenuity of surgeons, but less so now than formerly, because of the advances made in the technique of anaesthesia and the development of thoracic surgery in general.

Where the cyst approaches the periphery of the lung and the pleural surfaces are already adherent from preceding inflammatory reaction, the technical difficulties of surgical approach are reduced to a minimum.

This fact has, in the past, led to much effort being devoted to produce these conditions artificially where they did not exist naturally, and so the "two-stage" operation was very popular. The records demonstrate amply that the measures adopted to produce pleural adhesions at the site of election by such means as iodine gauze packs, insufflation of iodized talc powder or the preliminary intrapleural injection of 7 minims of a 10 per cent solution of silver nitrate as advocated by Brock (1942) have all been unreliable in their results. Frequently the second-stage operation has revealed either no adhesions between the pleural surfaces, or adhesions which were so delicate as to be inadequate.

Generally speaking, the type of case where it is desirable to have adherent pleural surfaces is the complicated cyst where bacterial infection is already present (i.e., what amounts to a lung abscess) and it is in this sort of case that the associated pleurisy usually provides the required condition.

Where the cyst is intact, and with modern anaesthetic technique giving positive intrapulmonary pressure, surgical approach through the free pleural space gives excellent results which compare favourably with those of the two-stage method. When the one-stage procedure is adopted the chief problem arises from the pericyst cavity in the lung, after the ectocyst has been removed, because of the frequency with which this cavity has a fistulous opening into one or more bronchioles. If such fistulae can be obliterated firmly by suture and there is freedom from sepsis, then primary suture of the lung is feasible. Even so it is wise to anchor the suture line to the parietal pleura and to provide a tubular drain through the wound to the exterior, lest post-operative coughing re-open any of the closed fistulae. Only in this way can the risks of tension pneumothorax and surgical emphysema be avoided. When fistulae are present and cannot be securely closed by suture, safe convalescence is ensured only by marsupialization of the pericyst margins to the parietes. Water-seal drainage of the pleural cavity through a separate stab wound until airtight sealing-off of the lung and pleura is assured, may be required as an additional precaution against the risk of pneumothorax.

The records contain many instances where neglect of the foregoing precautions has caused considerable trouble to the patient and anxiety for the surgeon during convalescence which, as a result, has been stormy and prolonged.

TABLE 6.

RESULTS OF TREATMENT IN THE SERIES OF 221 CASES OF PULMONARY HYDATID CYST.

(Australian Cases)

(1) Those not submitted to surgery	39 cases
Recovered by vomica	12
Relieved of symptoms	5
Remained chronic	10
Result not recorded	8
Died from hydatid cyst	4
(2) Those who underwent operation	182 cases
Recovered	164
Died	7
Operative failures	11

RESULTS OF TREATMENT IN THE SERIES OF 232 CASES OF PULMONARY HYDATID CYST.

(New Zealand Cases)

(1) Those not submitted to surgery	52 cases
Recovered by vomica	24
Relieved of symptoms	6
Remained chronic	12
Result not recorded	6
Died from hydatid cyst	4
(2) Those who underwent operation	180 cases
Recovered	166
Died	14

Operative mortality rate for all cases — 6%.

TABLE 7.

CAUSES OF DEATH IN CASES OF PULMONARY HYDATID CYSTS.

1. Hydro-pneumothorax and bronchial fistula.
2. Pneumothorax.
3. Empyema necessitans.
4. Bronchial fistula and infected lung.
5. Emphysema and empyema.
6. Surgical emphysema.
7. Asphyxia — blood clot in larger bronchi.
8. Dyspnoea — bronchial fistula into large liver cyst.
9. Pulmonary abscess and post-operative empyema.
10. Rupture of pulmonary cyst fifteen days after operation for hydatid of liver.
11. Purulent broncho-pneumonia — multiple cysts.
12. Persistent bronchial fistula and gastric ulcer.
13. Hydatid cyst of cerebellum as well as cyst in lung.

The general results of treatment of pulmonary hydatid cysts in this series are set out in Table 6 and the causes of death are listed in Table 7. On the whole, having regard to the fact that these are the results of many different surgeons throughout Australia and New Zealand, the relatively low operative mortality rate of 6 per cent must be regarded as most satisfactory. The incidence of chronic symptoms after spontaneous rupture of a cyst, or following its removal by operation, cannot be derived from the records, for the reason that there has been no systematic reporting of follow-up information. Nor has it been possible to obtain any very exact idea on this aspect from the results of the recent follow-up search in New Zealand. What has emerged from this investigation is that the vast majority of ex-patients remain free from symptoms and physically fit for an indefinite number of years — i.e., morbidity is, generally speaking, very low.

However, amongst this group of patients who are physically fit and free from symptoms and who show no relevant radiographic abnormalities on straight X-ray films, it has been found that bronchogram studies commonly reveal some degree of abnormal dilatation of the bronchi in the lobe from which the cyst has been removed.

In view of statements made in some recent articles on pulmonary hydatid disease, it would seem pertinent to emphasize that such degrees of bronchiectasis are for the most part symptomless. The patients are totally unaware of any departure from normal and only very rarely are there physical signs present which would suggest even mild bronchiectasis. To illustrate this contention, a few examples of bronchograms are reproduced together with short case history notes in Figs. III, IV, V, VI and VII.

While this finding is the predominant one, it cannot be denied that there are some cases which do not follow this happy course. Either the bronchiectatic state is already gross when the patient first comes under observation or else subsequently acquired respiratory infection aggravates the condition. This is most likely to occur with infected cyst cavities after spontaneous partial evacuation by vomica. In the neglected and most severely infected cysts there may have already occurred so much destruction of lung tissue as to render necessary the consideration of lobectomy as the only satisfactory treatment.

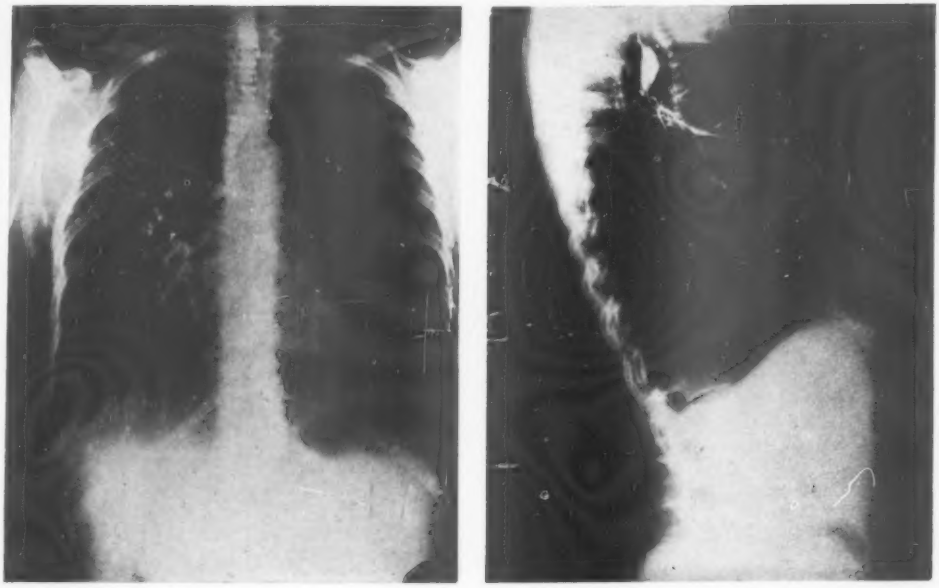


FIG. III.

(A) (B)

Case 161 — M.J.M. — Female aged 18.

1919. Seven months symptoms prior to removal, in one stage, of a hydatid cyst of the upper lobe of the right lung, through partially adherent pleural. Bronchial fistula present — drained — healed within four weeks.

1924. Hydatid cyst of liver removed — uneventful recovery.

1948. Now aged 48 years. Has remained free from chest symptoms for 29 years. She is healthy in all respects. Clinically, a few scattered moist sounds at the end of inspiration can be heard in the right axilla.

Casoni — Negative. Hydatid Complement Fixation — Positive.

Straight X-ray: The right dome of the diaphragm is elevated and under it some calcification is present (?) cyst wall.

BRONCHOGRAM: The middle lobe has expanded at the expense of the upper, which is relatively small. Bronchiectatic changes involve the pectoral bronchus of the right upper lobe and the axillary branch of the sub-apical bronchus. The other bronchi appear normal.

Examples of this type of problem are also illustrated by reproduction of bronchograms and case history notes in Figs. VIII and IX.

It has been stated by some writers on the subject that persistence of the pulmonary cavity after removal of the cyst and the co-existence of bronchiectasis is so frequent that treatment of pulmonary hydatid cysts by the usual methods cannot be regarded as satisfactory and that therefore lobectomy offers a greater likelihood of freedom from symptoms.

The experience of New Zealand and Australian surgeons, as revealed in this series of Registry cases does not support such contentions as the above. There can be little justification for the operation of lobectomy in the primary treatment of hydatid lung cyst *per se* and the advocacy of such a drastic procedure does not accord with the requirements of any but an extremely small minority of cases, all of which have gross destruction of lung, which fact, and not the hydatid cyst, determines the need for removing the destroyed lobe.

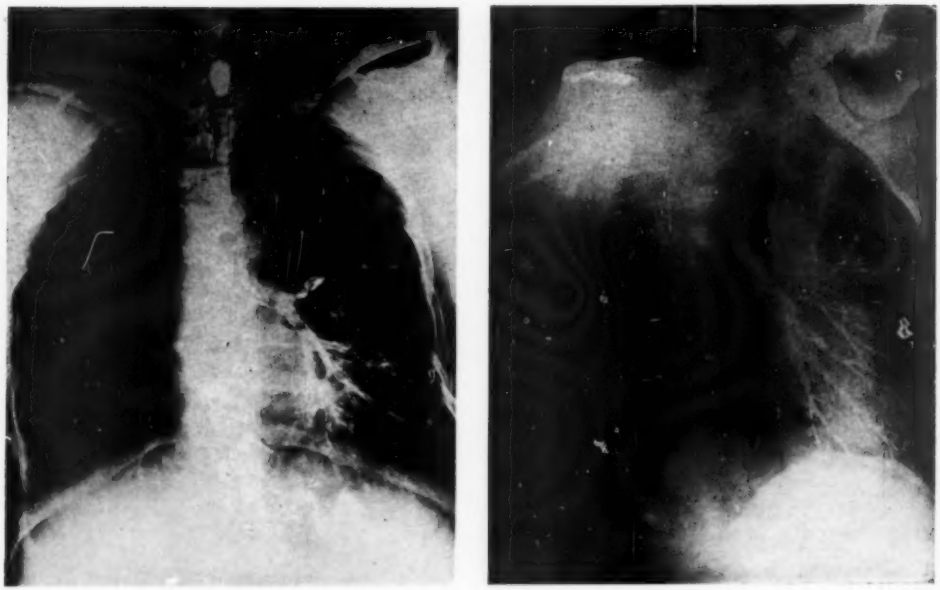


FIG. IV.

(A) (B)

Case 488 — O.T. — Male aged 6.

1932. Symptoms for a few months prior to operations for bilateral hydatid cysts of lungs. One-stage procedure in each case with interval of four months between. Pleural surfaces free and were sutured before extraction of cyst. Stormy convalescence after each operation.

1948. Has remained in consistent good health during the past 15 years with complete freedom from any chest symptoms. Clinical examination of the chest is normal

Casoni — Negative. Hydatid Complement Fixation — Negative.

Straight X-ray: Irregularity of the left 7th and right 8th and 9th ribs indicate the previous operations. Apart from the thickening of the pleura in the costophrenic angles, the lung fields seem clear.

BRONCHOGRAM: The left upper lobe has expanded at the expense of the lower which has contracted. The upper lobe bronchi are normal. The first dorsal bronchus and the posterior basal bronchus show evidence of saccular bronchiectatic changes They are displaced upwards and backwards.

Very rarely, severe haemorrhage occurring during the removal of a hydatid cyst may require lobectomy as the only means of dealing with the bleeding, but this again is to be classed as a complication.

FOLLOW-UP RECORDS.

The cases have been widely scattered throughout the whole of New Zealand and, due to changes of address, or for other reasons, the majority could not be traced; of those who replied to letters, only a relatively small proportion could be induced to report for further examination.

In all, 96 patients have been traced and examined. The results are classified and tabulated as follows:—

(1) Spontaneous rupture—no operation	21
(2) Uncomplicated cysts treated surgically	40
(3) Complicated cysts — local removal	28
(4) Complicated cysts — resection of lobe	4
(5) Empyema present	3

1. Where rupture occurred, with the exception of one patient, in which symptoms

still persist after eight years, the illness lasted over periods from as short as six weeks to as long as five years before the patient was completely rid of symptoms. The patient whose symptoms still persist after eight years probably requires a lobectomy, but no reason is stated for her not having had this done. The remaining 20 patients are all in good health, living active lives, and have been entirely free from any chest symptoms for periods varying from two years up to twenty-eight years. In 6 of these patients there is X-ray evidence of lung damage, described as "increased lung markings," probably indicative of some bronchiectatic changes; the remaining 14 have normal chest radiograms. No recent bronchograms were obtained in any of these cases.

2. Of the 40 patients with uncomplicated cysts which were submitted to surgical removal, 9 one-stage operations were done through pleural surfaces already adherent, and 4 were dealt with by two-stage methods,

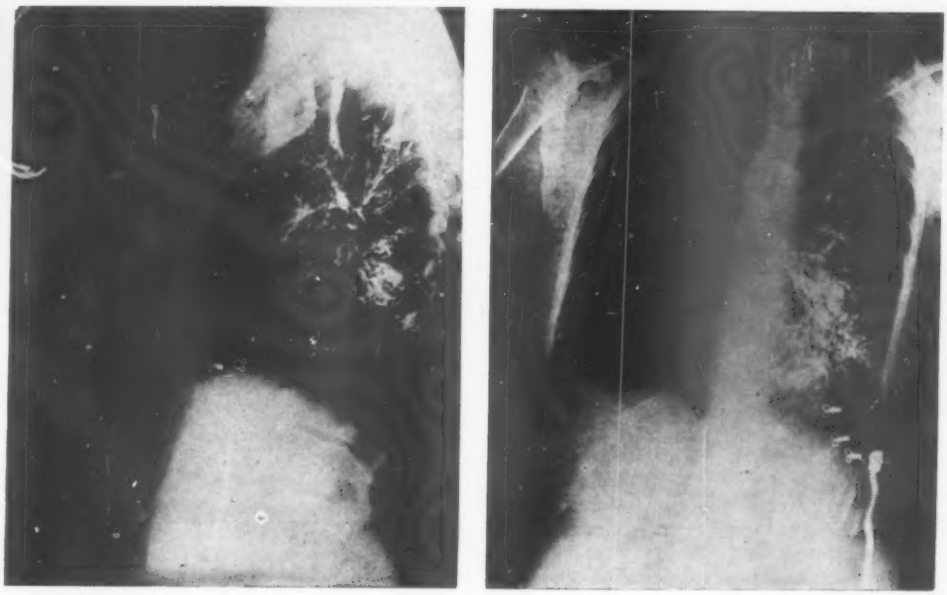


FIG. V.

(A) (B)

Case 287 — A.D. — Female aged 31.

1923. Symptoms had persisted for six years and had been regarded as due to tuberculosis. Two months prior to operation, coughed up hydatid membrane. Removal of infected hydatid cyst in left upper lobe by one-stage operation through partially adherent pleurae.

1948. Gives a history that nine months after the foregoing operation she was again in hospital with a pulmonary abscess in the right lung which resolved spontaneously. Since 1924 she has kept in very good health and has remained free of symptoms.

Casoni — Positive. Hydatid Complement Fixation — Positive.

Straight X-ray: Fibrotic shadows are present in the left middle zone. The oblique fissure is displaced backward, suggesting contraction of the left lower lobe. The right costo-phrenic angle is obscured, probably the result of an old pleurisy.

BRONCHOGRAM: The left lung was investigated. The volume of the upper lobe had increased considerably at the expense of the lower lobe, which is contracted. The upper lobe bronchi appear normal. The lower lobe bronchi are gathered in a cluster round the former site of the cyst. Most of them show bronchiectatic changes and several saccular cavities are present.

using an iodine gauze pack to produce pleural adhesions. The remaining 27 cases had operations performed through the free pleural cavity; some surgeons had sutured the pleural surfaces before incising through them, but where positive pressure anaesthesia was available, this procedure had been omitted.

The universal practice was to suture the pericyst cavity to the parietal pleura after the cyst had been removed and to drain temporarily the pericyst cavity. While a bronchial fistula existed, drainage was continued.

There were no deaths in this series. Bronchial fistula persisted for nine months in one case before it closed spontaneously. In another, suppuration occurred in the pericyst cavity because no drainage had been used, but this cleared up after the insertion of a drain on the fourth post-operative day. A third case has bilateral pulmonary tuberculosis which was present at the time of operation.

Empyema complicated the convalescence in 2 cases due to fistula and collapse of the lung post-operatively.

In the follow-up recently completed, with the exception of the tuberculous patient, all patients in this group are fit, active and in employment. Only 4 cases have been shown to have recurrence of hydatids in the lung, pleura, or scar of the previous operation. In 2 of these no post-operative drainage had been employed and tension pneumothorax had occurred. The remaining 2 had presented difficulties at operation and spilling of hydatid fluid had occurred.

Apart from these 4 cases of recurrence, X-ray appearances of lung fields are reported as free from cavities or cysts and, except for an occasional observation of "increased lung markings" in a few of them, the majority present nothing abnormal to X-ray observation. The histories of 2 of these patients are given in detail, together with bronchograms, as examples of complete recovery, but both show symptomless bronchiectasis. (Case 161, M.J.M., Fig. III; Case 488, O.T., Fig. IV.)

3. Of the 28 complicated cysts treated by local removal, 11 were dealt with by two-stage methods in order to secure adhesion between the parietal and the visceral pleura, but in 14 others the pleural surfaces were already adherent, so that a first stage was not required. Drainage of the infected pericyst was adopted in every case. In all of these 25 cases, the subsequent health has remained excellent and X-ray examination has revealed no evidence of lung damage. In none has there been persistence of the pericyst cavity. A few have shown local pleural thickening at the site of previous

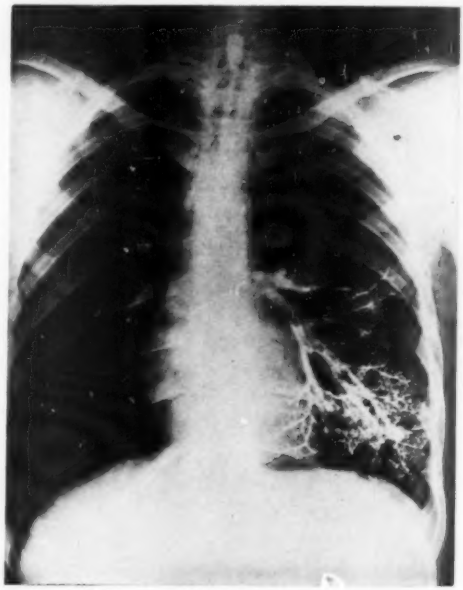


FIG. VI.

Case 1905 — E.A.O. — Male aged 17.

1945. Spontaneous rupture of unsuspected hydatid cyst of left lower lobe. Treated expectantly for three months and then operation through adherent pleura to remove the infected cyst and drain abscess cavity. Good recovery made.

1948. Has remained symptom free four years and lives an active life. Looks fit and has no chest signs clinically.

Casoni—Positive. Hydatid Complement Fixation—Negative.

Straight X-ray: A deficiency in the 9th left rib indicates the site of the surgical approach to the cyst. Some crowding of the vascular markings in the left lower lobe suggest fibrotic changes in the dorsal broncho-plumonary segments of this lobe. Otherwise the lung fields are normal.

BRONCHOGRAM: The left basal bronchi are displaced backwards and several saccular bronchiectatic cavities are present in relation to them. The first dorsal bronchus appears normal.

pleural adhesions, as would be expected. All are free from any chest symptoms, or physical signs, for periods up to ten years or more since their operations.

As in the case of the uncomplicated cysts, there are examples of symptomless bron-

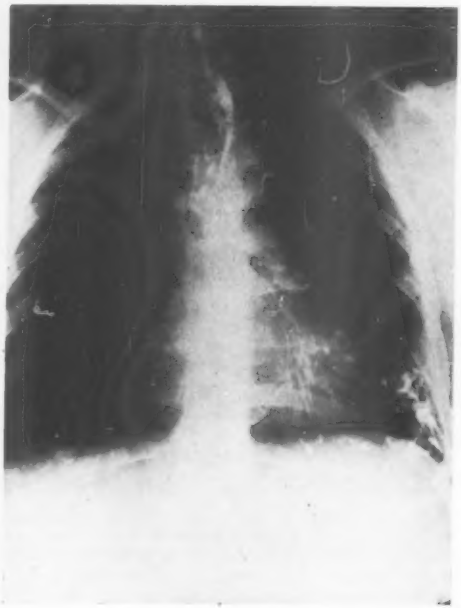


FIG. VII.

Case 1389 — R.S. — Male aged 10.

1939. Expectant treatment of hydatid cyst of lower lobe of left lung for eighteen months, during which time he had purulent sputum and occasional haemoptyses. Operation: drainage of a lung abscess. Pneumothorax followed and convalescence was stormy. Eventual recovery after three months with re-expansion of the lung.

1948. Has remained well and free from symptoms for nine years. Looks healthy and lives an active life. Clinically: slight diminution of air entry in left lower lobe with some moist *râles*, after coughing, in this area.

Casoni—Negative. Hydatid Complement Fixation—Negative.

Straight X-ray: In the left lower lung field are linear crescentic shadows which might well be the wall of a hydatid cyst. Some pleural thickening is present in the left costo-phrenic angle, but otherwise the lung fields are clear.

BRONCHOGRAM: The upper lobe bronchi were not filled completely because of the distortion of the bronchial tree, but those branches which were filled appear to be normal. The lower lobe bronchi are greatly distorted and the basal branches show evidence of gross bronchiectatic changes.

chiectasis. Of these cases, 3 are illustrated with brief summaries: (Figs. V, VI and VII).

The remaining 3 cases require special mention.

(1) A male patient aged 20, presented with a partially empty, ruptured cyst occupying almost the whole of the left lower lobe. At operation the cyst was enucleated, the raw surfaces of pericyst sutured to obliterate the space and the chest closed without drainage. Tension haemo-pneumothorax followed and required a second operation which was followed by recovery. This patient is now free from symptoms, but the sequence of events illustrates the necessity for drainage in all cases where bronchial fistula is likely.

(2) A patient with bilateral cysts, operated on by the same surgeon, was dealt with in a similar manner to the foregoing, with the additional precautions of obliterating all bronchial fistulae with cotton sutures before closing the pericyst and providing water-seal drainage of the pleural cavity. Post-operatively, bronchoscopy was required to aspirate a considerable amount of blood from the bronchial tree. Success attended the method in this case and the patient left hospital in eighteen days. This patient, six months later, is very well, free from symptoms, and with nothing abnormal in the X-ray appearances of the lung fields.

(3) A patient was diagnosed as having a pleural effusion, and X-ray examination did not give further help as to the cause. Aspiration of chest precipitated severe coughing and respiratory distress. Later, X-ray examination revealed a ruptured hydatid cyst and collapsed lung. At operation there was thick fibrinous exudate over the whole of the collapsed lung. Decortication of lung, removal of hydatid cyst and marsupialization of the pericyst, together with water-seal drainage of the pleural cavity, resulted in recovery. Six months later X-ray examination of the chest shows only a small bronchial fistula which still persists.

4. Complicated cysts treated by resection of lung tissue in 4 cases had had local removal of pulmonary hydatid cysts, eighteen years, fifteen years, eight years and one year ago respectively; 2 had gross bronchiectasis affecting one lobe, for which lobectomy was performed. The other 2 exhibited gross disorganization and collapse of almost the whole of the lung resulting from multiple infected cysts, and were treated by pneumonectomy.

All have recovered and are now in satisfactory health after many years of previous ill-health.

The bronchograms of 2 of these cases are illustrated in Figs. VIII and IX.

5. The 3 patients in whom empyema was present with a hydatid cyst as the originating cause have been traced. One case, occurring in 1937, was diagnosed correctly only as the result of hydatid membrane

FIG. VIII.

Case 2049 — W.F. — Male aged 46.

1933. Pains in right chest later developing a pleural effusion. Hydatid cyst of right lower lobe found on X-ray examination and removed by operation at a country hospital. Following this he was left with a persistent sinus in the chest wall. This gave little trouble apart from occasional slight discharge and sometimes moderate bleeding. He was referred to Dunedin Hospital because the sinus had persisted for fifteen years.

1948. General health very good. Clinical examination revealed no abnormality of the chest apart from the sinus complained of.

Casoni—Positive. Hydatid Complement Fixation—Negative.

BRONCHOGRAM: Right upper lobe bronchi are normal. Middle lobe bronchi are displaced upwards and forwards. Lower lobes, the bronchi are displaced backwards. There is some degree of bronchiectasis of the anterior basal and terminal bronchioles in this lower lobe—appearances which could be due to fibrosis of this lobe.

appearing through the drainage tube placed in the pleural cavity. Recovery from this illness was achieved in five weeks. Eleven years later the X-ray appearance of the chest is normal except for slight elevation of the diaphragm and obliteration of the costophrenic sinus. The Casoni test is positive, but the hydatid complement fixation test negative. The patient himself has meanwhile enjoyed excellent health.

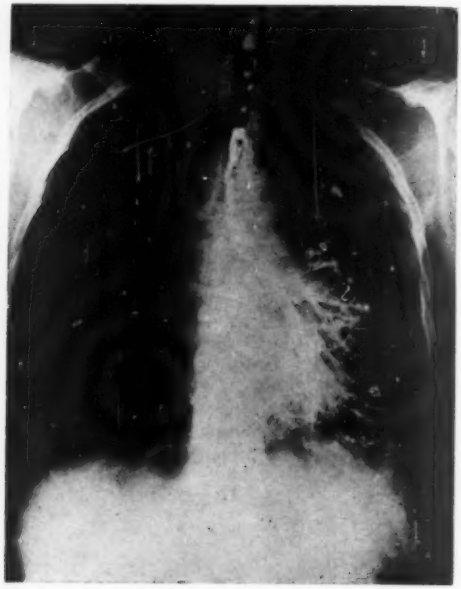


FIG. IX.

Case 1627 — V.R.L. — Male aged 29.

1941. Symptoms for six weeks prior to removal of hydatid cyst from the left lower lobe. Purulent discharge continued for two months before healing was achieved.

1942. A second cyst was removed from the right lower lobe by two-stage operation.

1944. A third cyst was removed from the left lung; was in hospital 3 months.

1948. Follow-up: Now aged 37 years. Health has been poor since 1940. Still has a chronic productive cough with purulent sputum. Has been unfit for work for seven years. Clinically: Looks ill. There is evidence of gross destruction of the left lung.

Casoni—Positive. Hydatid Complement Fixation—Positive.

Straight X-ray: There is an opaque shadow in the left lung field adjacent to the left border of the heart.

BRONCHOGRAM: The left bronchial tree is greatly deformed. A large bronchiectatic cavity is present in relation to the secondary division of the apical bronchus. A saccular bronchiectasis also involves the anterior branch of the pectoral bronchus in which segment a hydatid cyst is now present. The lingular bronchus is grossly deformed but seems normal. Practically all the lower lobe bronchi are bronchiectatic—i.e., deformed and displaced. Earlier operations had been performed at other hospitals. The patient was admitted to the Dunedin Hospital in 1948 and a total pneumonectomy of the left lung was performed. He is now well and free from symptoms for the first time in almost eight years.

The remaining 2 cases of empyema, presenting as such, were secondary to rupture through the diaphragm of a hydatid cyst in the right lobe of the liver. Both responded well to the usual treatment of the chest lesion combined with evacuation and removal of the hepatic cyst through the diaphragm during the course of the thoracotomy operation. Now, three years, and one year, after operation respectively, both are well, free from symptoms and with normal X-ray findings.

LABORATORY TESTS.

Casoni and hydatid complement fixation tests were performed on 25 patients, all of whom had remained free from symptoms and had enjoyed good health since removal of their lung cysts. Twenty-two of these patients were normal on clinical examination, with normal X-ray films of the chest.

The results were as follows:—

Both tests negative	9 cases
Complement fixation negative, Casoni positive	8 cases
Complement fixation positive, Casoni negative	3 cases
Both tests positive	5 cases

Of the last group, in which both tests were positive, 3 had demonstrable evidence of hydatid cysts still present. The remaining 2 were apparently free from infestation and had been in excellent health for ten years and twenty-four years respectively. It may be of some significance that both the latter are instances of spontaneous cure by coughing up the hydatid cyst.

SUMMARY AND CONCLUSIONS.

Records of 478 cases of pulmonary hydatid disease occurring in Australia and New Zealand over the past twenty-five years have been analysed in detail. Of the New Zealand cases recorded it has been possible to trace 96 patients; further examination of these clinically and by X-rays has been made and specific laboratory tests carried out.

During the period under survey, striking developments have occurred in the realm of anaesthetics and the technique of their administration. To this fact, more than to any other, must be attributed the great advances made possible in the development of thoracic surgery. Positive pressure inhalation anaesthesia with controlled respiration has solved many of the former difficulties in chest surgery, so that there is not now the same need for two-stage operations as was formerly the case.

This survey of hydatid disease of the lungs establishes the following facts:—

1. Although hydatid disease is a preventable affliction, it continues to flourish with undiminishing vigour in sheep-farming areas where the disease is endemic amongst dogs.

2. Males are afflicted more commonly than females and the clinical evidence of infestation becomes apparent chiefly in the 20 to 30 years of age decade.

3. Presenting symptoms of pulmonary hydatids arise from leakage of the cyst contents which usually gives rise to a pneumonitis. This causes a cough and pleuritic type of pain associated with some sputum which may be bloodstained at intervals.

4. Diagnosis is difficult and, apart from the rare occasions when hydatid elements can be recognised in the sputum, reliance has to be placed upon specific tests and X-ray appearances.

Specific tests alone can be relied upon to give positive results in only 70 per cent of cases where one or other will be positive. Hydatid complement fixation and Casoni tests can be expected to give combined positive reactions in 36 per cent of cases only. It follows that no special reliance can be placed on negative tests, as indicating freedom from the disease.

Eosinophilia is subject to so many vagaries as to render it valueless as an aid to diagnosis.

X-ray examination of the lung fields, provided that both antero-posterior and lateral views are taken, will usually establish a diagnosis and is essential for preoperative localization of the cyst within the lung. Difficulties arise where there is associated pleural effusion and cases also occur where the differentiation from other types of pulmonary lesions may be extremely difficult.

Bronchograms and repeated X-ray examinations at intervals will usually be of value in the diagnosis of this type of case.

5. The right lung is more commonly the site of cysts than the left, and daughter cyst formation is relatively rare.

6. Spontaneous cure by rupture of the cyst and its evacuation by vomica is hazardous to the patient and uncertain in its final result. Cases presenting in this state should be observed over a period and dealt with on their merits according to the particular circumstances of each case. Some few may never require surgery; others will do so because of superadded infection giving rise to what amounts to a pulmonary abscess.

7. Surgery will be required for the majority of cases and should preferably be undertaken early in uncomplicated cysts. Delay involves the risk of spontaneous rupture with its attendant complications, which will invariably require surgery.

As regards surgical management, the following principles are inviolable:—

(a) Above all other precautions, spilling of the contents of a living hydatid cyst must be guarded against by protecting the pleural cavity and the parietal wound with adequate swabs, packs and towels. A fine needle combined with a Fitzpatrick suction bell should be used for reducing the tension of contained hydatid fluid preparatory to removing the ectocyst.

(b) Marsupialization and drainage of the pericyst cavity is unquestionably the safest method of coping with bronchial fistulae which are so frequently present, or which may develop after removal of the ectocyst from rupture of thinned walls of bronchioles.

(c) The use of formalin in any strength to swab the pericyst cavity is deprecated. It is probably valueless for its intended purpose and entails a risk of bronchial irritation when a fistula is present.

(d) Local removal of the whole cyst is the immediate objective and should remain the sole purpose of any surgical operation. All the results of such procedure have been excellent as regards cure of the disease and very seldom has anything more been required.

8. Closure of the pericyst cavity postoperatively has presented no problem where marsupialization and drainage have been employed. Exceptionally, final closure has been delayed for rather long periods, but this is not observed unless complicating factors are present.

9. Permanent dilatation of bronchi can usually be demonstrated in cases where bronchograms are performed after the removal of a hydatid cyst. In the series of cases reviewed, bronchiectasis so caused remained symptomless in the majority of cases and was not apparent in straight X-ray films. It calls for no treatment and the patients remain in excellent health unless superadded infection is acquired later.

10. Gross disorganization of the lung, resulting from infective processes which have complicated a ruptured hydatid cyst either before or after its removal, is the only indication for lobectomy or pneumonectomy. There would seem to be no justification for adopting such procedures as these in the treatment of hydatid cysts *per se*, but in exceptional cases lobectomy may be required as the only means of dealing with severe haemorrhage occurring during the removal of a cyst.

11. One-stage removal of hydatid cysts across a free pleura, with modern technique of positive pressure anaesthesia, is safe and gives results equally as good as the two-stage operations, provided marsupialization of the ectocyst is carried out and facilities for water-seal drainage of the pleural cavity are available should pneumothorax develop.

REFERENCES.

BARRETT, N. R. (1947), *Thorax*, vol. 2, page 21.

BROCK, R. C. (1942), *Guy's Hosp. Rep.*, vol. 91, page 99.

BROWN, C. J. O. (1942), *Roy. Melb. Hosp. Clin. Rep.*, vol. 13, page 66.

CHRISTIE, H. K. (1939), *Aust. N.Z. J. Surg.*, vol. 8, page 373.

DAVIDSON, L. R. (1944), *J. Thoracic Surg.*, vol. 13, page 471.

DÉVÉ, F. (1916), *Arch. Méd. exp.*, vol. 27, page 113.

DEW, H. (1928), "Hydatid Disease". Sydney: The Australasian Medical Publishing Company, page 135.

DOUGLAS, D. M. (1948), *Edin. Med. J.*, vol. 55, page 78.

FITZPATRICK, S. C. (1945), *Aust. N.Z. J. Surg.*, vol. 14, page 269.

LOGAN, A., and NICHOLSON, H. (1948), *Thorax*, vol. 3, page 1.

SUSMAN, M. P. (1948), *Thorax*, vol. 3, page 71.

UNILATERAL RENAL ECTOPIA WITH RENAL CARCINOMA.

By M. S. S. Earlam, A. L. Carrodus and V. S. Howarth.

(From the Department of Urology, Royal Prince Alfred Hospital, and the University of Sydney.)

THE incidence of unilateral renal ectopia has been variously estimated. Thompson and Pace (1937) place it at one in every 10,000 patients examined at the Mayo Clinic. Thomas and Barton (1936) found 22 examples in 22,000 necropsies. According to the latter authors the clinical incidence is one in every 547 complete urological examinations.

Crossed renal ectopia is a much rarer clinical condition than homolateral ectopia, but tumour formation in the crossed ectopic organ has been recorded with greater frequency. McKenzie and Hawthorne (1937) described a crossed right ectopic kidney associated with an inoperable neoplasm, but did not describe the histology of the tumour. Borchardt (1932) removed a left crossed ectopic kidney which contained a large adenoma. Patch (1937) removed a left crossed ectopic kidney containing a tumour of hypernephroma type. Langworthy and Drexler (1942), describing two cases of crossed renal ectopia associated with neoplasm, state that "Carcinoma, either in the crossed fused or unfused kidney, has never been described." The latter authors apparently overlooked the previous papers quoted and in the single patient upon whom they operated, the histology of the tumour was not recorded. Their second patient refused operation and therefore the presence of a neoplasm was not confirmed. Lee (1948) described a squamous cell carcinoma occurring in a right crossed ectopic kidney which he removed at operation.

With regard to unilateral renal ectopia associated with tumour growth, surgical literature contains the following references: Wulff (1907) records a carcinoma arising in a pelvic kidney associated with calculi. He does not discuss the pathology of the neoplasm, but from its association with a calculous pyonephrosis, it is assumed that it would most likely have been a squamous carcinoma. Cabot (1918) quotes Young (1912) as having described a hypernephroma in an ectopic kidney lacking a suprarenal gland. Unfortunately Young's original paper is not available in this country. Campbell (1930) describes a hypernephroma in a left-sided ectopic kidney lying over the left sacroiliac joint, but does not record whether this was a clinical or a post-mortem finding.

The occurrence of a tumour of hypernephroma type in a homolateral ectopic kidney is therefore very uncommon and the following case is the third to be recorded in world literature and is possibly the first in which operative removal has been successfully carried out.

Case Report.

A male aged 41 complained of attacks of severe pain which he referred to his left hypochondrium. These attacks had been present for eighteen months and occurred at about three-monthly intervals, but over the two months before he sought medical advice he had been experiencing an attack once or twice a week. The pain was severe and described as a "knife-thrust which lasted from ten minutes to half an hour." Following the attack of pain, he would shiver and would later vomit clear fluid. Over the past eighteen months he had lost 14 pounds in weight, his appetite had been poor, and he had noticed gaseous eructations after meals. He did not complain of any other symptoms and specific interrogation directed towards the urinary system did not elicit any relevant information.

His past history included an attack of appendicitis some years before and the repair of a right inguinal hernia. He had also suffered a severe crushing injury to the lower abdomen, from which he stated that he had made a complete recovery.

Abdominal examination disclosed scars of a Battle's incision and of an incision for a right inguinal herniorraphy. In the hypogastrium, and slightly to the right of the mid-line, could be felt a tumour which was of somewhat irregular contour and of firm consistency, was slightly tender, was fixed and did not carry any transmitted pulsations. Its size was approximately that of a normal kidney.

The urine was clear, with only a very occasional leucocyte to be seen on microscopy and was sterile on culture. The haematological findings were normal except for a 12 per cent eosinophilia. The Casoni intradermal test for hydatid disease gave immediate negative and delayed negative reactions, and a Graham's test disclosed a normally functioning gall-bladder.

FIG. I. Radiograph of the abdomen after barium enema which discloses a filling defect in the medial wall of the caecum, suggesting the presence of an extrinsic tumour.

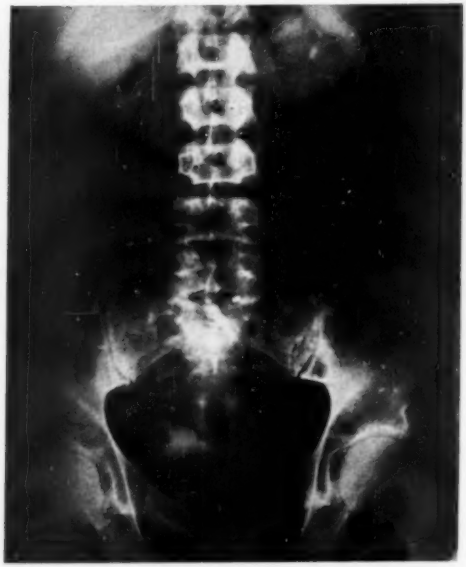


FIG. II. An intravenous urogram. The left kidney is normal in position and shows good function. There is no kidney shadow to be seen in the right flank and the outline of the right renal pelvis can be seen in the mid-line overlying the lumbo-sacral joint. Note the filling defect in the superior wall of the bladder.

In view of these findings, a clinical diagnosis of carcinoma of the caecum was made. A barium enema was given and followed by X-ray studies of the caecum and colon, which showed a filling defect of the caecum that could have been due to an extrinsic tumour (Fig. I). An intravenous urogram was obtained, which showed the right renal pelvis to be in the mid-line in front of the lumbo-sacral articulation. (Fig. II)

At this stage the patient was referred to the urological department for further investigation, and cystoscopy was carried out. The bladder was found to be normal and effluxes of clear urine could be seen issuing from two normally situated ureteric orifices. Bilateral retrograde pyelography was performed. This showed normal findings on the left side with a somewhat bizarre appearance of the right ectopic kidney, in which the uppermost minor calyx was missing and the lower ones were somewhat dilated and elongated. (Fig. III)

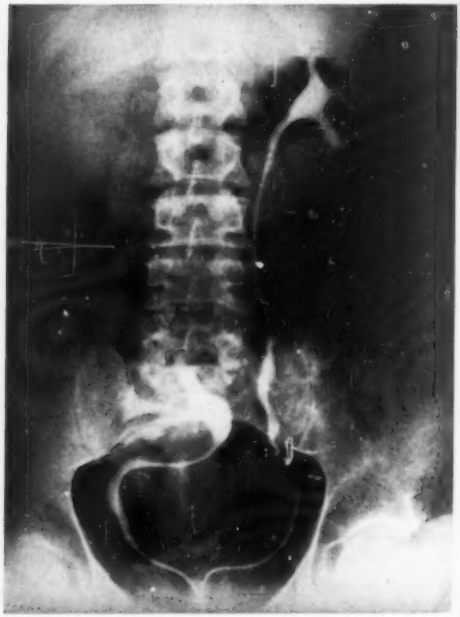


FIG. III. A bilateral retrograde pyelogram. The right renal pelvis is of bizarre shape and lies in the mid-line over the lumbo-sacral joint. The pelvis is directed medially, its upper calyx is under-filled and the lower and middle calyces show elongation.

In order to investigate further the condition of the right ectopic kidney, the cystoscopy was repeated seven days later and the right renal pelvis was completely filled with opaque medium. This occasioned a severe attack of pain which the patient spontaneously located in the left hypochondrium, stating that it exactly reproduced the pain of which he complained.

It was decided that nephrectomy should be performed. In the first place, in spite of the contralateral nature of the pain, it was considered, in view of the findings at the second cystoscopy, that the patient's left hypochondriac pain was due to some pathological lesion in his right kidney. In the second place, it was felt that a tumour could well be present in the ectopic kidney partly because such a kidney, unless pathologically enlarged, should not have been palpable through the abdominal wall, and partly because of the pyelographic deformity. At the same time, however, it was realized that this deformity could have been due to the old injury that the patient had sustained, or to the congenital abnormality *per se*, so that although the presence of a neoplasm was seriously considered before operation, the diagnosis was not positively made.

A mid-line lower abdominal incision was made. On opening the peritoneum the tumour was immediately obvious and was found to be covered by the mesentery of the terminal ileum which was stretched out over its surface. Only after lifting coils of ileum from the pelvis and packing them into the upper abdomen was the anterior aspect of the kidney exposed. This was found to lie more or less in the mid-line over the fourth and fifth lumbar vertebrae and the promontory of the sacrum. Perirenal fat was absent and no suprarenal tissue was seen. On incising the posterior parietal peritoneum the kidney was found to derive its blood supply mainly through two large leashes of vessels which disappeared into the upper end of the peritoneal incision toward the bifurcation of the great vessels. Following ligation and division of the vessels, the kidney was readily delivered and removed. The incision in the posterior parietal peritoneum was closed by a running suture and the abdominal incision closed without drainage.

Convalescence was disturbed by a minor degree of paralytic ileus during the first few days, but was thence uneventful.

When seen six months after operation the patient was well and stated that he had had no further pain in his left hypochondrium and was following his normal occupation of carpentry.

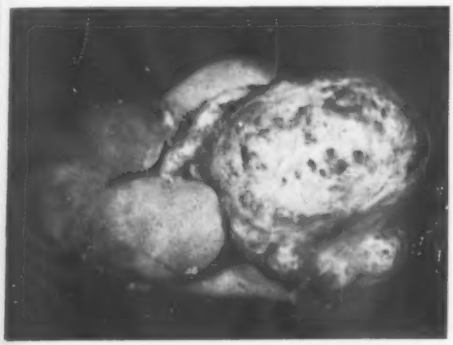


FIG. IV. The anterior aspect of the specimen removed at operation.

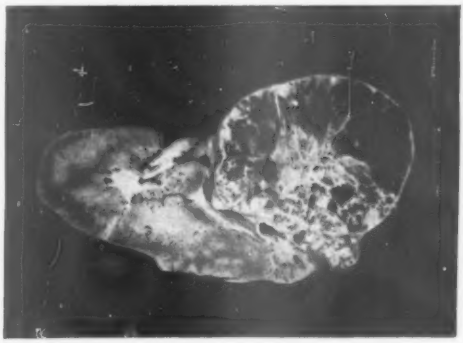


FIG. V. The ectopic kidney on section.

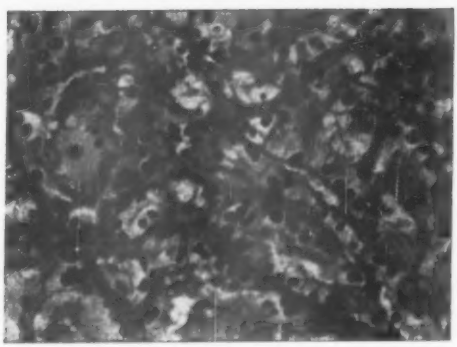


FIG. VI. A photomicrograph of the tumour. Haematoxylin and eosin. (x 200)

The specimen is illustrated in Figs. IV and V, which demonstrate that the kidney is irregularly oval in shape, while its lower pole is enlarged by a lobulated mass of tumour tissue. The renal pelvis is situated upon the relatively flattened anterior surface

and the ureter has been displaced medially by the tumour growth, around the medial surface of which it curves downwards to descend into the true pelvis. The upper half of the anterior surface of the kidney is deeply indented by a groove on either side which runs from the pelvis upwards and laterally, each groove containing a large leash of blood-vessels. The upper pole of the kidney shows two depressed areas in the depths of which blood-vessels can be seen entering the kidney cortex. The posterior surface of the kidney has been deeply indented by the promontory of the sacrum and is also marked by a longitudinal groove which at operation contained the middle sacral vessels. The tumour forms a lobulated spherical mass springing from the lower pole of the kidney and measures 6.2 cm. in diameter. The cut surface of the specimen shows that the tumour is spherical and surrounded for the most part by a well-marked fibrous capsule. In one area, however, the capsule of the tumour has been penetrated by the neoplasm which can be seen to be invading the renal substance. The tumour has encroached upon the lower portion of the renal pelvis. The centre of the tumour is occupied by a mass of whitish fibrous tissue and the remainder has a variegated appearance, part of it being somewhat lobulated. Some of the lobules are bright yellow in colour, whilst others are represented by cystic spaces containing clear jelly-like material and others have heavily bloodstained contents. The remainder of the cut surface of the kidney does not show the usual orderly arrangement of pyramids and cortical tissue.

The histology of the tumour is illustrated in Fig. VI. The growth is a carcinoma formed of clear cells. Some of the cell masses have distinct lumina and are tubular in structure, but in other parts form solid masses and strands.

DISCUSSION.

The case herein reported has several interesting features apart from the rarity of the pathological condition, namely the crossed nature of the patient's pain which was referred to the opposite hypochondrium and the production of pain on over-distention of the pelvis of the ectopic kidney of an identical nature to that complained of. This pain was relieved by the nephrectomy.

Rusche and Bray (1943) point out that the symptomatology presented in cases of renal ectopia is usually that of abdominal and pelvic conditions rather than that characteristic of renal abnormalities, and draw attention to the fact that renal ectopia should be considered in the differentiation of abdominal pain and tumours of obscure origin.

A transperitoneal approach is the method of choice for the removal of an ectopic kidney lying at the brim of the pelvis or below, and, as noted by Laidley and Howarth (1949), even when the organ lies at a higher level on the right side, an extraperitoneal approach to it may be rendered technically difficult by the presence of a previous muscle-splitting incision which is commonly present in such cases. In the surgical approach to the removal of the low-lying right ectopic organ it is to be remembered that the mesentery of the terminal ileum is usually stretched out over its anterior surface and can easily be damaged during the surgical approach, and that during the subsequent repair of the posterior parietes the blood supply of the terminal ileum is in jeopardy.

SUMMARY.

1. A record is made of a Grawitz tumour arising in an ectopic kidney. This is the third case to be placed on record and possibly the first case of successful surgical removal.

2. The main complaint was of atypical abdominal pain which was referred to the opposite side of the upper abdomen. This pain was reproduced by over-distension of the pelvis of the ectopic kidney and disappeared after nephrectomy.

3. There were no complaints that could be clinically attributed to the ectopic organ.

4. Technical difficulties in the surgical approach are discussed.

5. A review of the literature is included.

ACKNOWLEDGEMENT.

We are indebted to the Department of Medical Artistry, the University of Sydney, for the photographic illustrations of this paper.

REFERENCES.

BORCHARDT, M. (1932), *Med. Klinik.*, vol. 1, page 439.

CABOT, H. (1918), "Modern Urology." Philadelphia: Lea and Febiger, page 622.

CAMPBELL, M. F. J. (1930), *J. Urol.*, vol. 24, page 191.

LAIDLEY, J. W. S., and HOWARTH, V. S. (1949), *Aust. N.Z. J. Surg.*, vol. 19, page 40.

LANGWORTHY, H. T., and DREXLER, L. S. (1942), *J. Urol.*, vol. 47, page 776.

LEE, H. P. (1948), *Trans. West Sect. Amer. Urol. Assoc.*, vol. 15, page 39.

McKENZIE, D. W., and HAWTHORNE, A. B. (1937), *Trans. West Sect. Amer. Urol. Assoc.*, vol. 6, page 19.

PATCH, F. S. (1937), *Brit. J. Urol.*, vol. 9, page 339.

RUSCHE, C. F., and BRAY, J. L. (1943), *J. Urol.*, vol. 50, page 129.

THOMAS, G. J., and BARTON, J. C. (1936), *J. Amer. Med. Assoc.*, vol. 106, page 197.

THOMPSON, G. J., and PACE, J. M. (1937), *Surg. Gynec. Obstet.*, vol. 64, page 935.

WULFF (1907), *Dtsch. Med. Wschr.*, vol. 33, page 1882.

THE HISTOLOGY OF GASTRITIS.

By R. K. Doig and R. Motteram.

(From the Clinical Research Unit of the Walter and Eliza Hall Institute of Medical Research, Royal Melbourne Hospital.)

(Aided by a grant from the National Health and Medical Research Council.)

THE study of the histology of the stomach has been handicapped in the past by the rapidity with which autolysis and loss of the superficial portion of its mucosa occurs when the mucosa has been deprived of its blood supply. There have been three methods by which material for histological examination has been obtained and fixed so as to reduce this rapid autolysis.

Historically, the first method was the performance of an early autopsy which became satisfactory only when the peritoneal cavity was injected with formalin immediately after death. The earliest work of Faber (1935), who has made greatest use of this method, appeared at the beginning of this century. Using this method, the variable effect of the final illness and possible changes at the time have to be considered, although comparison with biopsy results suggests that these are often minimal.

The second method was the study of stomachs removed at operation for peptic ulcer and for carcinoma. These operative specimens were available for early fixation. However, these patients suffer from a restricted group of clinical conditions. There are numerous diseases in which gastric disorder plays a part, but for which gastrectomy is not performed. Konjetzny was among the earlier workers who used this material, and his conclusions are summarised and critically reviewed by Schindler (1947). From this method of study, antral gastritis as a possible cause of an ulcer-like history and the common association of antral gastritis with peptic ulcer, were recognised.

Biopsy of the stomach constitutes the third method. By this method one may obtain material from successive biopsies enabling study of a sequence of histological appearances in the one patient. This has been done in some patients through an abdominal incision, as reported by Schindler and Ortmayer (1942), but such a procedure is too drastic to be used as a routine.

In the past few years gastroscopes have been made with biopsy forceps incorporated in them (Kenamore *et al.* 1946, Benedict 1948, d'Almeida 1948), but few papers on the use of such instruments have appeared. It would seem that operative skill and safety factors would be limiting features of this method. However, it permits biopsy of an area seen through the gastroscope and enables the course of a disease to be followed.

Recently we have taken part in the development of a technique for gastric biopsy, using a flexible gastric biopsy tube (Wood *et al.*, 1949a). With this instrument fragments from the mucosa of the body of the stomach can be readily obtained and serial studies made. The method has two disadvantages. First, the biopsy is done blindly; it is therefore of no use in diagnosing ulcer from cancer. This is a problem where gastroscopy is of proven value and where gastroscopic biopsy would be even better. Secondly, one must assume initially that the specimen obtained is representative of a diffuse lesion in the body of the stomach.

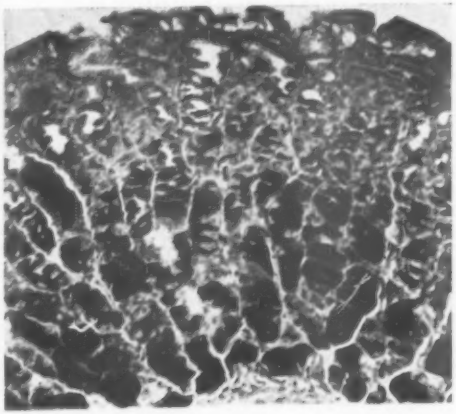
Our reasons for accepting the view that the specimen is representative are two-fold. When two specimens are obtained from neighbouring sites the pictures presented are almost always similar, and when test-meal results are compared with biopsy findings, a close correlation between the two is possible, more particularly when localised lesions such as ulcer or carcinoma of the stomach are excluded (Wood *et al.*, 1949b).

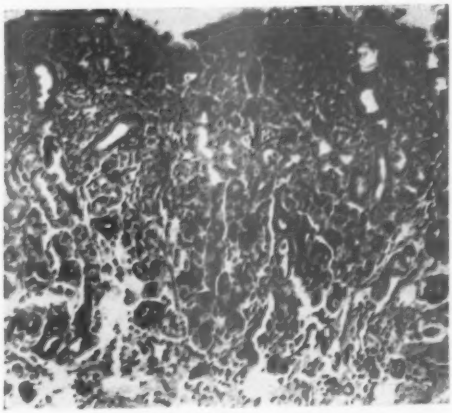
The technique has been described previously (Wood *et al.*, 1949a). To date, biopsy has been attempted 370 times in our clinic and has been successful 304 times. Of these biopsies, 231 have been performed by one of us (R.K.D.). From the 278 patients on whom one or more attempts have been made, fragments of gastric mucosa suitable for histological examination have been obtained in 246. On seventy occasions gastroscopy was carried out immediately after gastric

biopsy. Frank haematemesis or melaena has occurred four times. Haemorrhage has been the sole complication, but has not presented any great problem in management. One patient was transfused to hasten convalescence, but in no case was life considered to be endangered.

The method has its chief use in diffuse lesions of the body and fundus of the stomach where radiological examination shows no local ulcerative or neoplastic change. It is of no use in the diagnosis of antral gastritis.

Various stains are used in the preparation of sections. As a routine, haematoxylin and eosin, haematoxylin and mucicarmine, and a stain for pepsinogen granules, are used. In the earlier part of our work the stain for





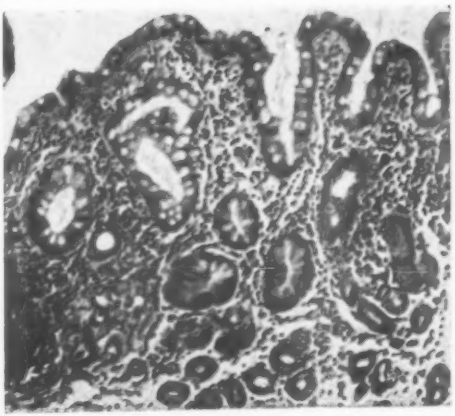


FIG. I. (Above): Biopsy from the mucosa of the body of the stomach in a normal subject. Test meal normal. Note the columnar epithelium of surface and pits, gastric glands containing purple staining pepsinogen-secreting chief cells and pink-staining acid-secreting parietal cells. The lamina propria is free from wandering cells. (Trichrome stain. x115.)

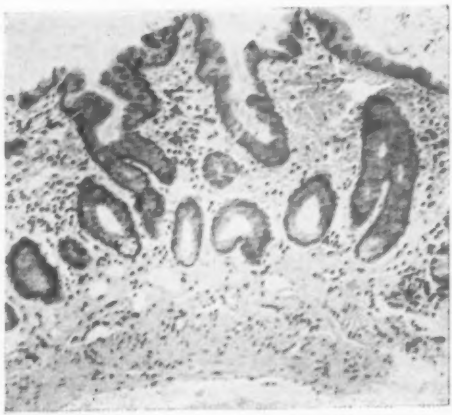


FIG. II. (Above): Case 1. History of intermittent indigestion for four years. Test meal normal. Biopsy from the mucosa of the body of the stomach. Portions of the surface epithelium are flattened. The superficial lamina propria shows pink-staining oedema fluid and a dense infiltration with wandering cells. There is a little atrophy of chief and parietal cells in the upper portions of the gastric glands. (Trichrome stain. x 115.)

FIG. III. (Below): Case 2. History of recurrent epigastric pain for forty years. Test meal—achlorhydria. Biopsy from the mucosa of the body of the stomach. There is atrophy of the gastric glands which are represented by a few small clumps of chief and parietal cells at the base of the mucosa. Surface epithelium and pits show intestinal metaplasia. (Trichrome stain. x130.)

FIG. IV. (Below): Case 3. Suffering from pernicious anaemia. Test meal—achlorhydria. Biopsy from the mucosa of the body of the stomach showing extreme thinning from complete atrophy of chief and parietal cells. There is complete intestinal metaplasia of the residual epithelium (Haematoxylin and mucicarmine. x130.)

pepsinogen granules was a modification of the pepsinogen stain of Bowie and Vineberg (1935). Recently it has been found by one of us (R.M.) that the addition of methyl green as a nuclear stain and Ponceau phloxine to stain parietal cells gives a good contrast staining of the principal elements of the gastric mucosa. We consider this is the most informative single stain for gastric mucosa (Fig. I.).

It is the purpose of this paper to demonstrate the histological features of gastritis by reference to biopsy findings in 4 patients and briefly to set forth the clinical features of each case. The surface of the normal gastric mucosa consists of a mucus-secreting columnar epithelium from which arise the gastric pits lined by epithelium of similar character. Into these pits open the gastric glands which are of simple tubular type. The cells of these glands are pepsin-secreting chief cells and acid-secreting parietal cells. These three cell types are well differentiated from each other in the trichromatic stain (Fig. I). In the normal mucosa from the body of the stomach, wandering cell infiltration of the lamina propria is small in amount and limited to the superficial portion.

In gastric disease the simplest changes observed are confined almost entirely to the upper part of the mucosa. There may be migration of polymorphonuclear cells into the pits and on to the surface. The surface epithelium becomes flattened and the pits are lengthened at the expense of the tubular glands. Wandering cells, including polymorphs, lymphocytes, plasma cells and macrophages, occur between the pits and there is often local oedema subjacent to the surface epithelium. The surface epithelium may be shed in parts, and oozing could then occur from underlying capillaries. The extent to which the specific tubular glands are affected runs parallel with the extent of the wandering cell infiltration. In more advanced cases the infiltration spreads downwards and chief and parietal cells atrophy in the more superficial portions. We have applied the term superficial gastritis of catarrhal type to this group.

The following case is typical of this group.

CASE 1.

C.C., a female aged 37, was referred to the Clinical Research Unit with a history of intermittent indigestion for four years. She complained of epigastric pain and fullness immediately after meals. Symptoms would be present for a few days, but the remissions were also short. Symptoms varied in severity, but produced no vomiting or loss of weight. In addition she said she suffered from "nerves" and at times had "splitting headaches," pains in the left arm, and discomfort after micturition. Psychiatric opinion was that she was "a fairly composed woman, shows little evidence of anxiety, and with some of the efficiency facade of the underlying emotionally dependent person who develops gastric symptoms frequently." Clinical examination revealed vague tenderness in the epigastrium. Barium meal examination and gastroscopy were normal. The histamine test-meal showed secretion of 26 units of free acid. Gastric biopsy was performed on two occasions and both sections showed superficial gastritis (Fig. II).

The patient was then allowed to rest in hospital and dieted as for an ulcer. On discharge, the biopsy picture had returned to normal and histamine provoked a secretion of 42 units of free acid. Six weeks later, however, a fourth biopsy again showed superficial gastritis.

In gastritis, all grades of change towards complete atrophy can be seen. In atrophic gastritis there is a disappearance of chief and parietal cells except in a few scattered clumps at the base of the mucosa. The surface epithelium tends to be more variable. It may stain more intensely with mucicarmine, and patchy to almost confluent intestinal metaplasia may occur. The metaplastic change is often abrupt and the altered epithelium shows the typical intestinal attributes of a striated border, goblet cells and Paneth cells. Typical intestinal crypts may be formed.

The cellular infiltration is similar except that quite large lymphoid collections are common and polymorphs are much less in evidence. From a number of cases the impression is gained that the degree of atrophy is proportional to the duration of the inflammation and that, at any time, the severity may vary independently. Long-standing dyspepsia is a common symptom, as is illustrated by the patient whose history is now recorded.

CASE 2.

F.L., a female aged 65, was referred to the Clinical Research Unit for investigation. For forty years she had suffered from indigestion lasting one to two weeks, with shorter intervals of freedom. The indigestion took the form of flatulence and epigastric ache immediately after meals. This ache radiated to the right iliac fossa and to the top of the shoulders, and it lasted for two or three hours. There was partial relief with alkaline powder. Her

appetite was good and her weight constant. For four years she had noticed progressive weakness, and for six months, pallor. She also complained of recurrent ulcers on the tongue.

Examination showed a pale woman (but the haemoglobin was 13.4 g. per cent). The tongue was smooth. There was slight tenderness in the epigastrium and the right iliac fossa. The blood pressure was 170/100. Barium meal examination was normal. Gastroscopy was not performed. Histamine test-meal showed achlorhydria. Gastric biopsy showed a severe atrophic gastritis (Fig. III).

The patient has been observed for nine months and treated with an ulcer diet, sedatives and alkaline powders. There has been some symptomatic improvement, but lately family illness and worry have had an adverse effect.

Lastly, in pernicious anaemia, one sees a gastric mucosa in which atrophy of chief and parietal cells is usually complete and inflammation minimal. There is an increase in the number of argentaffine cells, and intestinal metaplasia with goblet cells and Paneth cells is very common. But one is, as yet, unable to say accurately by what route this has been reached. It may be the last stage of chronic inflammation passing through the stages described above, or it may be a result of a more special noxious action whereby atrophy of the gastric glands occurs with very little inflammatory change. Atrophic gastritis of pernicious anaemia is illustrated by a third case.

CASE 3.

W.T., a male aged 62, was first admitted to the Royal Melbourne Hospital in 1947. He then had typical pernicious anaemia with weakness, pallor and shortness of breath. Dyspepsia had been present irregularly for fifteen years. He showed an adequate response to liver therapy. Gastric biopsy was performed two years after his admission to the hospital and showed the typical atrophic mucosa of pernicious anaemia (Fig. IV). There had been no regeneration of the specific gastric glands. At that time his haemoglobin was 15.7 g. per cent. His tongue was smooth and he still had symptoms and signs suggestive of cord involvement.

These 3 cases demonstrate three types of change we have found in patients on whom gastric biopsy has been performed. The first case illustrates that "gastritis" may be present even when the patient has a psychogenic cause for her symptoms. The second case shows an atrophic change with active inflammation matched by a long history of flatulent dyspepsia. The third case shows the dyspepsia which may antedate the development of pernicious anaemia by some years. The clinical pictures vary considerably. Relapse of the gastritis may cause epigastric ache, anorexia and loss of weight. Small erosions may produce mild anaemia. On examination, there may be epigastric tenderness and achlorhydria or hypochlorhydria. The following case illustrates the problem presented to the surgeon when this development of the disease occurs.

CASE 4.

L.R., a female aged 44, was referred to the Clinical Research Unit with a history of dyspepsia for twenty months, and a loss of 42 pounds in weight. For many years she had asthma, but this was not causing any inconvenience. The dyspepsia consisted of intense nausea and vomiting not particularly related to meals. Severe burning pain in the left side of the abdomen, anteriorly, sometimes followed the vomiting. On examination the patient had hypertension and tenderness to the left of the umbilicus. Barium meal examination was normal shortly after the onset of symptoms and again a year later. Histamine test-meal produced only 3 units of free hydrochloric acid. Gastric biopsy showed a severe catarrhal gastritis with atrophy. There was a possible cause for symptoms in the patient's domestic background, but reassurance that she did not have cancer had a dramatic effect.

Gastric biopsy thus gives positive evidence of an alternative lesion in patients with greatly reduced acid secretion and a long history of dyspepsia. It enables a diagnosis of gastritis to be made in those patients where there is no evidence of peptic ulcer or of carcinoma.

SUMMARY.

(1) The various methods by which material has been obtained for histological examination of the stomach are briefly discussed.

(2) The advantages and limitations of blind biopsy, using a flexible gastric biopsy tube, are set forth.

(3) Cases are presented in which biopsy has been used and three representative types illustrated.

(4) Photomicrographs from sections of these biopsy specimens are proffered as proof of the adequacy of the material, and the importance and value of differential stains is pointed out.

ACKNOWLEDGMENTS.

We wish to acknowledge the help received from Dr. Ian Wood, Head of the Clinical Research Unit, and Dr. E. S. J. King, Pathologist to the Royal Melbourne Hospital, and those members of the Honorary Medical Staff who referred the cases. Mr. Matthaei, of the Faculty Workshops, University of Melbourne, prepared the photomicrographs.

REFERENCES.

BENEDICT, E. B. (1948), *Gastroenterology*, vol. 11, page 281.

BOWIE, D. J., and VINEBERG, A. M. (1935), *Quart. J. Exp. Physiol.*, vol. 25, page 247.

d'ALMEIDA, CARMENA (1948), *J. Amer. Med. Assoc.*, vol. 136, page 842.

FABER, K. (1935), "Gastritis and its Consequences." Oxford: University Press.

KENAMORE, B., SCHEFF, and WOMACK, N. A. (1946), *Arch. Surg.*, vol. 52, page 50.

SCHINDLER, R., and ORTMAYER, M. (1942), *Amer. J. Digest. Dis. Nutrition*, vol. 9, page 411.

SCHINDLER, R. (1947), "Gastritis." London: William Heinemann Ltd., page 247.

WOOD, I. J., DOIG, R. K., MOTTERAM, R., and HUGHES, A. (1949a), *Lancet*, vol. 1, page 18.

WOOD, I. J., DOIG, R. K., MOTTERAM, R., WEIDEN, S., and MOORE, A. (1949b), *Gastroenterology*, vol. 12, page 949.

DIVERTICULA OF THE SMALL INTESTINE.

By E. S. J. King.
Melbourne.

Hic locus est partes ubi se via findit in ambas.
(Virgil. Aeneid. Bk. vi., l. 540.)

DIVERTICULA of the small intestine occur in various forms which may be, and have been, classified in several ways. These classifications depend on various features such as the time of development of the diverticula (before or after birth), the presence or absence of muscle in their wall, their size, position on the wall of the bowel or the association with other conditions. Thus there are divisions into "congenital" and "acquired," true and false, anti-mesenteric and mesenteric and Meckel's and "non-Meckelian" forms amongst others. Most of these are spurious, since they depend on assumed or implied differences which, when examined, are found to have no real basis.

One important distinction is that of the Meckel's diverticulum from others. This type is well defined not only because of its characteristic form and position, but also on account of its clear-cut and thoroughly determined formation from the vitelline duct. The others constitute a group which does not have any definite location, and the diverticula may be single or multiple. Amongst these there are some which develop during embryonic life, but though often of large size and with a thick muscular wall, do not have the same significance as the Meckel's diverticulum, but arise from the tissues of the developing bowel wall. Their main importance is that their special features have provided some morphological justification for a segregation of antenatal from post-natal types.

The form described here is that found in adults (though its relationship to the type just mentioned will be discussed), occurring usually in the mesenteric border of the jejunum, and thus the structures are often referred to as jejunal diverticula.

Until the last few years diverticula of the small intestine were regarded as uncommon, but increased attention to them and accumulating records of groups of cases have indicated the fallacy of this. They occur usually without producing symptoms or signs, and so to the pathologist, who sees them frequently, they are structures which are rarely complicated, while to the clinician, who usually becomes aware of them only when they are complicated, such complications are prominent and important. Similar discrepancies occur in regard to opinions as to incidence; those who look for them specially at post mortem find them relatively frequently, whereas to the radiologist they were until recently a rarity.

The literature contains many discrepancies of various kinds (and more than its fair share of misquotations). Some of the earlier writings have now only a limited value, but, if considered in relationship to their period, they throw light on the gradual development of various opinions and on the origin of some of these which can now be recognized as untenable.

Historical.

The first case of multiple diverticula described and illustrated appears to have been that of Astley Cooper in 1807. In 1822 Meckel described the type which now bears his name, and distinguished between true and false diverticula (according to whether they had muscle in their wall or not), an idea which influenced pathological thought on the nature of these structures for the remainder of the century. At the same time the making of this distinction implies that Meckel and his contemporaries were by no means ignorant of the type discussed here.

The next published accounts of pathological specimens or clinical cases were made by Wallman (1858), Cornillon (1869), Osler (1881) and Moore (1883). Moore presented his case at a meeting of the Pathological Society of London, and from the account of the subsequent discussion, in

which Sir Frederick Treves took part, it is apparent that the condition was quite well known; thus it is clear that a count of formally published cases at any period is no indication of current knowledge.

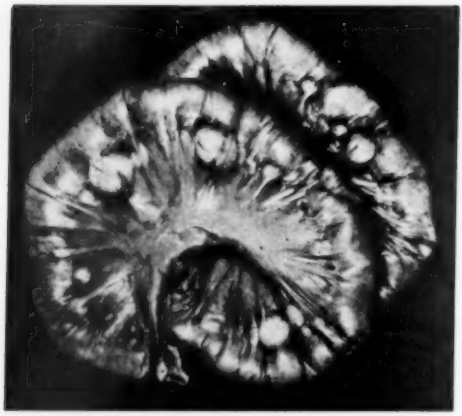


FIG. I. Photograph of coils of jejunum showing numerous diverticula from a male aged 92 years. The diverticula are distributed irregularly along the bowel on or close to the mesenteric border. (Cf. Fig. XX.)

Further examples were recorded by Buzzi (1885), Edel (1894) and Seippel (1895), and that of Hanseman (1896), which showed 400 diverticula, is a famous, oft-quoted case. An Australian case was recorded in 1906 by Johnson, and in 1910 Sir Arthur Keith discussed 7 cases amongst a group of others of the alimentary canal — a further instance of a group of cases not recorded under the specific term which would be overlooked in a casual search of the literature.

Apart from an example of a single diverticulum in a boy of six years of age described by Buchwald and Janicke (1887) all the cases up to 1906 were found at autopsy, but in this year Gordinier and Sampson recorded an example of multiple diverticula observed at operation. Another case operated on was reported by Zengerle (1911), and from 1920 onwards many of the recorded examples were so observed.

In 1920 Case recorded an example demonstrated during X-ray examination of an opaque meal. Other instances of this kind gradually appeared (Hunt and Cook 1921, Baastrup 1924, Heidecker 1926, Tengwell 1930), until Ritvo and Votta (1946) observed 25 cases radiologically over a period of two and a half years.

The literature has been reviewed by various writers. In 1921 Terry and Mugler collected 19 cases; in 1924 Watson found 26 cases and Rothschild 33 cases, and in 1927 Gisbertz collected 50 cases; in 1934 Rosedale and Lawrence collected 78 cases; but Chapman, who made a good review, refrained (wisely) from attempting a positive count. In 1938 Gerster found 187 cases, and in 1943 Benson *et al.* accumulated over 300 cases. The literature of the complications was well reviewed by Walker in 1945.

The numbers of the cases at any period given by the various authors are only of limited value, since such reviews in many cases are obviously incomplete. Not only are some of the cases specifically described and listed in the literature overlooked, but also many examples described incidentally with other conditions (admittedly easily missed) are omitted. Furthermore, as indicated above, it is obvious that recorded cases are not necessarily an index of frequency of occurrence nor an indication of interest in or knowledge of them. However, the figures provided do give some idea of growth of interest in the condition and of the period during which the diverticula have become well known.

INCIDENCE.

The recorded incidence of intestinal diverticula varies greatly with different writers. This is due to a number of factors. The age group examined, the kind of examination made (pathological or radiological) and the care and attention to detail with which it is performed, all influence the number of positive observations. Reinhardt (1926) found 3 examples in 5.000 post-mortem examinations and Edwards (1936) found 9 in 2820 such examinations. Rankin and Martin (1934) found 3 cases during 72,715 radiological examinations of the intestinal tract. On the other hand, Rosedale and Lawrence (1936), paying special attention to the small intestine, obtained post-mortem, and distending it with air, found 4 examples in 300 cases so examined. Thus the incidence ranges from 0.06 per cent to 1.3 per cent of cases. The figure most commonly quoted is 0.2 per cent to 0.3 per cent.

	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	
M.	—	—	2	2	13	3	2	1	23
F.	1	1	1	2	2	1	1	—	9
	1	1	3	4	15	4	3	1	32

TABLE I. The age and sex incidence in a series of cases occurring amongst 5,000 post mortem examinations. During the period over which these were found, 3 cases were seen at operation: a female aged 59 years (Fig. XX), a male aged 60 years (Fig. XXV) and a male aged 64 years. (Fig. 28). Two other cases in male children, aged 4 months (Fig. II) and 10 years (F.g. VII), were encountered at the Children's Hospital.

The writer, from post mortem examinations in a general hospital in which the average age at death is high (being from 55 to 60 years at different periods), has found an incidence of 0.6 per cent. In these cases only an ordinary reasonably careful examination has been made. The series is too small to draw far reaching conclusions, but consideration of the gradually increasing recognition of the condition and the high figures obtained by special techniques suggests that this is close to a real figure for this age group. In a series of 5,000 post mortem examinations carried out at the Children's Hospital, Melbourne, no case was found, but 2 examples were seen at operation.

It is apparent, therefore, that any statement regarding general incidence of diverticula which does not specify the age group and the method of examination is without value.

The age incidence also varies in different accounts; clearly there will be a difference according to whether the ages at death (*i.e.*, post mortem figures) or ages at which some abdominal condition, not necessarily the diverticula, is discovered (*i.e.*, operation figures) are considered. Nevertheless, there is some general agreement. The majority of cases is found over the age of 40 years, and usually the greatest incidence is in the seventh decade. In this respect the writer's cases agree with those of larger series.

The cases found in young individuals are usually of the single type. Examples in children under ten years of age are uncommon, but have been described by Brandes (1929), Buchwald and Janicke (1887), Glans (1920), Hunter (1922), Kozinn and Jennings (1941), McMurrich and Tisdall (1928) and Somerford (1930). Two such are illustrated here (Figs. II and VII).

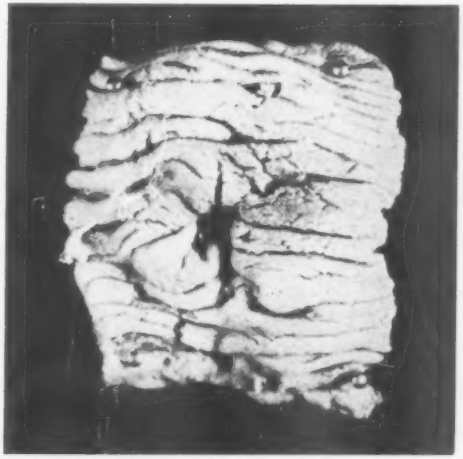


FIG. II. Photograph of a segment of jejunum removed (at operation) from a male aged 4 months. The opening of the diverticulum is on the mesenteric border. (Cf. Fig. 111.)

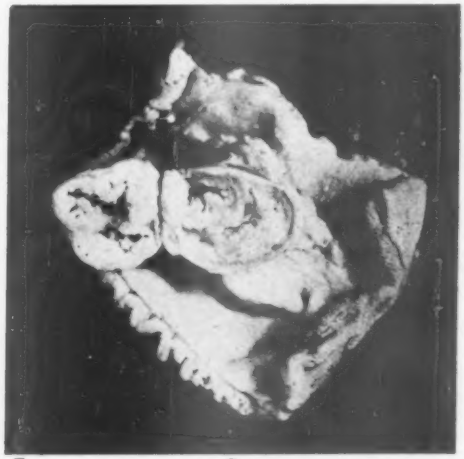


FIG. III. Photograph of the exterior of the piece of intestine shewn in Fig. II. The relationship of the diverticulum to the cut mesentery is apparent. The mucosa of the diverticulum is very hyperplastic, almost filling the lumen. Histologically it is gastric in type.

Sex incidence is that of a uniformly male preponderance. This is usually of the order of male to female as two to one. The higher male incidence in the small series quoted here is probably explained by the total proportion of male to female cases of 3: 2.

Association of diverticula with other conditions is also variably recorded, though some reasonably constant features are to be found. In post mortem examinations, any disease or condition may occur as an incidental association, but two groups occur commonly. Atherosclerosis and its various complications (coronary occlusion, thromboses of various kinds and the like) are found in many cases—in 26 of the 32 cases described. This probably is merely a matter of the age period in which the conditions occur, but it should be mentioned that vascular changes have been regarded as having an aetiological significance.

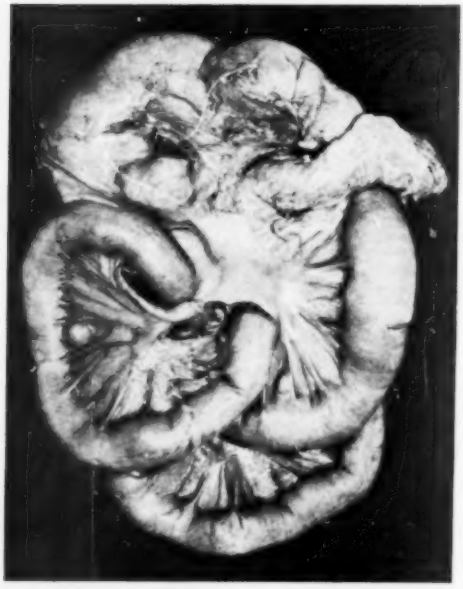


FIG. IV. Photograph of the duodenum (the body of the pancreas indicates the general position) and loops of jejunum from a male aged 66 years. There are two large diverticula projecting (upwards) from the third part of the duodenum and a diverticulum is present in each jejunal loop.

Diverticula of other parts of the alimentary canal occur frequently. There were, in the present series, an oesophageal diverticulum (associated with colonic diverticula), 5 in the duodenum and 8 in the colon in the present series. This kind of observation has been made by many writers, and the association of abdominal herniae (Sheppe, 1924) has been noted also. Other alimentary canal disturbances also may be associated; 2 cases of strangulation of the small intestine (not related apparently to the diverticula), gastric polypi and a gastric ulcer occurred in the present series. Diverticula of the bladder associated with enlargement of the prostate) are found fairly frequently, but this, like vascular disease, probably is a matter of the age group in which the intestinal diverticula are found.

In clinically observed groups, *i.e.*, those specially segregated for examination of the alimentary canal (or chosen because of symptoms suggesting alimentary canal disease) the association of alimentary canal diverticula (oesophageal, duodenal or colonic) is, of course, much higher. In either case it is apparent that there is some significant relationship between the various diverticula.

MORPHOLOGY.

General Features.

These diverticula are found along the length of the small bowel, more commonly in the jejunum than the ileum (7: 1), but in some cases involving a considerable length, and thus occurring simultaneously in both parts. They are more commonly multiple (as just indicated) and as many as 400 (Hanseman, 1896) have been counted. On the other hand they may be single (one-third of cases) or only a few found. Careful examination with distension of the gut sometimes shows other diverticula when only one or a small group is found on routine inspection.

These structures may have a thick or thin wall, the thickness being an indication of the presence of muscle tissue. This presence of muscle was regarded as being of fundamental importance and Meckel named those with muscle "true" diverticula, and those without "false." Because the Meckel's diverticulum which develops from the vitelline duct is an excellent example of the

"true" form, the terms gathered an aetiological significance, so that "true" became synonymous with "congenital" and "false" with "acquired." Neither of these distinctions is in any way illuminating.

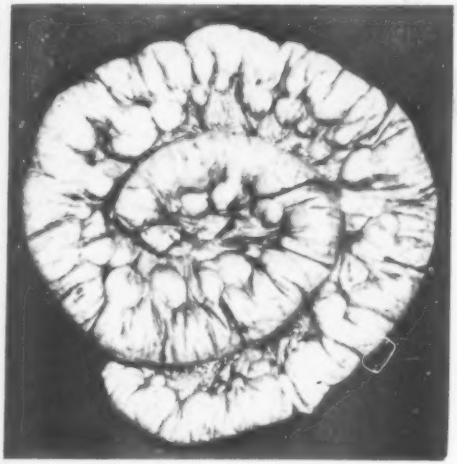


FIG. V. Photograph of loops of jejunum from a male aged 77 years. Numerous moderately large diverticula are present.

In the first place, the division of conditions into congenital and acquired is thoroughly misleading and confusing. The term "congenital" is one indicating the time of development of a condition, *i.e.*, that it is present at birth. The term does not constitute an antonym for "acquired." Conditions present at birth and arising before that event are congenital; but some of them are inherited while others are due to foetal disease, *i.e.*, they are acquired. Some of the conditions occurring or becoming apparent in the adult are inherited, though most are acquired. Thus the division into "congenital" and "acquired" is illogical and meaningless. If an aetiological distinction is required, conditions may be "inherited" or "acquired," or if it is a matter of time relationship, then they may be "antenatal" (*i.e.*, congenital) or "postnatal."

On the other hand, as will be shown, diverticula developing in later life, as well as those found in early life, may be demonstrated to have muscle in the wall. Thus, on the one hand, there is no real correlation between the "true" and "false" and the "antenatal" and "postnatal" forms, and on the other, since both "true" and "false" types are found together in the one case, it is clear that there is no fundamental distinction between them.

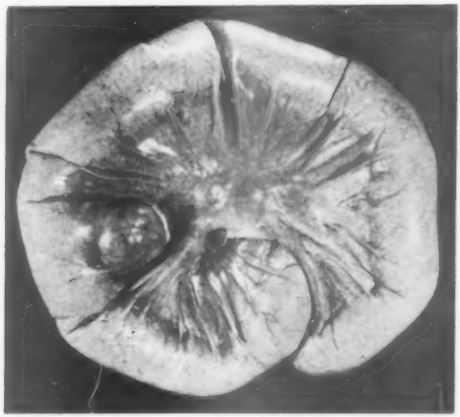


FIG. VI. Photograph of a loop of jejunum from a male aged 64 years shewing a single large diverticulum. Two other small ones were found lower in the intestine.

Nevertheless, in a general way the diverticula found in young people are different from those found in other individuals. It does not follow, however, that they are necessarily quite different in origin. If growing tissues and those fully grown are both subjected to the same abnormal stimulus, the result would be expected to be different. This question is discussed later. Meanwhile, the diverticula of the first decade are considered separately.

Diverticula in Young Individuals.

These structures are usually single. They have a wall of the same thickness as the neighbouring bowel and the muscle is in well-formed layers. The mucous membrane may be intestinal in type, but it is often gastric in form or may contain pancreatic tissue. The epithelial type is easily recognizable microscopically, but its nature may be apparent even macroscopically (Fig. VII).

These diverticula usually occur on the mesenteric border or close to it, but well developed examples are to be found on other aspects of the gut. In the ileum any diverticulum on or near the antimesenteric border

is assumed to be of a Meckel's type (and in the absence of evidence to the contrary this is reasonable), and even those on the mesenteric aspect are often so described. The justification for this last opinion is obscure, but certainly all diverticula of the jejunum are of a different kind.

FIG. VII. Photograph of portion of jejunum removed at operation from a male aged 10 years, viewed from the mucosal aspect. The opening of the diverticulum is apparent and the different (gastric) character of the diverticular mucosa (the diverticulum projecting from behind the bowel) is shewn.

These diverticula can be shown to be related, by way of some examples with narrow and elongated necks, to some of the mesenteric cysts. Gradations can be found also between them and reduplications of the gut. The earlier a disturbance occurs in embryonic life, the more gross the morphological change, so that the differences in structure (sometimes considerable) are indicative of the time of their origin rather than any significant difference in kind. Examples of these gross types were described by Evans (1929).

In size, diverticula range from small pouches of a few millimetres in diameter to large structures of several centimetres in diameter. The usual size appears to be of the same order as the bowel, *i.e.*, the long diameter is about the same as the moderately distended gut. The mucosa is often hyperplastic and this often encroaches on the lumen (Fig. III).

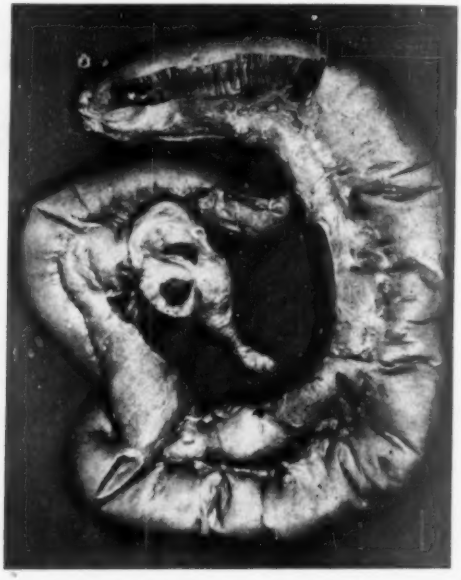


FIG. VIII. Photograph of an example of duplication of the intestine (from a male aged 15 years). Cf. Fig. IX.

As these diverticula are subject to the same complications as the adult forms, from this viewpoint both groups will be discussed together.

Diverticula in Adults.

These constitute the great majority of diverticula and are the ones to which reference is made particularly in this paper. Their various characteristics are considered separately.

Size:

The diverticula are spherical structures which vary in size from small projections of 2-3 mm. in diameter to large protuberant cysts of 9-10 cm. in diameter. The smallest ones may be overlooked unless the appropriate part of the bowel is artificially distended, but moderate sized ones are readily seen, and the larger ones, the diameter of which is much greater than that of the adjacent bowel, present a striking picture.

The actual measurement depends of course to some extent on the degree of distension of the bowel.

FIG. IX. Drawing to indicate the relationship of the diverticulum to the intestine (Fig. VIII). There is a long blind loop which is attached at several parts without communicating with the intestine.

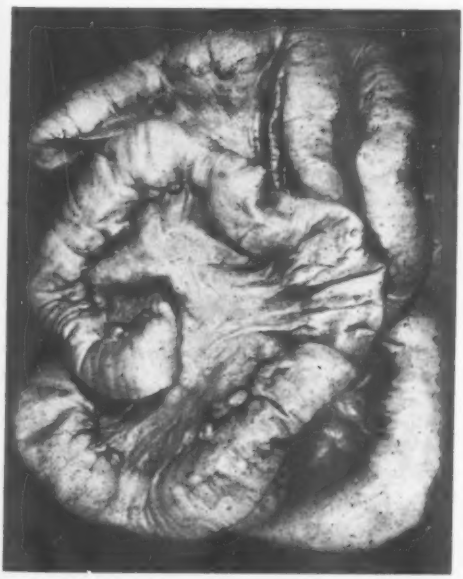


FIG. X. Photograph of loops of jejunum from a male aged 84 years, shewing numerous small diverticula.

The various diverticula in a given case are sometimes of about the same size, but it is usual for there to be considerable variation. The distribution of the various sizes is apparently haphazard, since large and small examples are intermingled without any apparent governing factor.

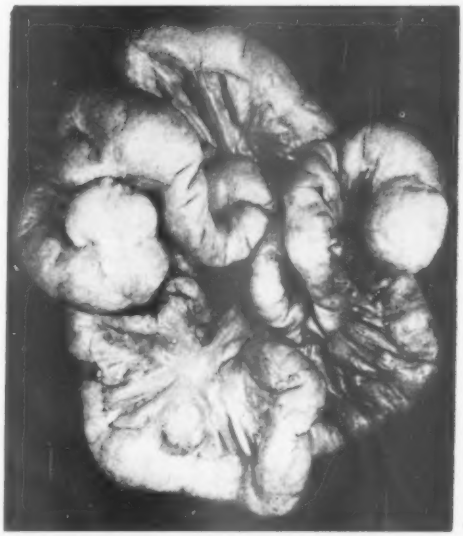


FIG. XI. Photograph of loops of jejunum from a female aged 77 years. Numerous diverticula are present and two are large. Dilatation of the bowel in the vicinity of the large diverticula is apparent.

Shape:

Most of the well developed diverticula are spherical. In the early stages they may be dome-like projections, but soon become hemispherical, and as they enlarge further become rounded. Small diverticula distend to become larger ones, but many of the larger forms at their inception involve more of the wall than the smaller ones.

Some of the diverticula are indented by a vessel running over their surface, but this usually disappears if the internal pressure is raised. Large diverticula within the mesentery may project on both sides, and these develop a bilocular form, the constriction being due to mesenteric tissues. The two loculi are unequal in the upper part of the jejunum, but may be equal in the lower portion.

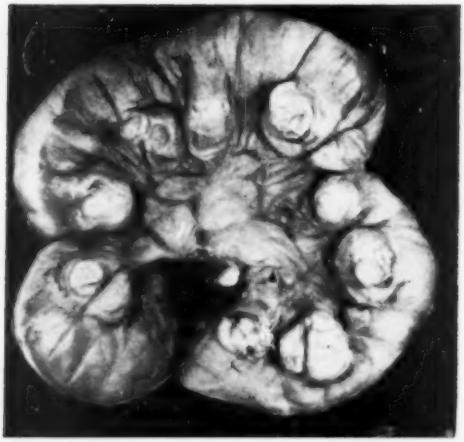


FIG. XII. Photograph of loops of jejunum from a male aged 46 years. The diverticula shew some irregularity due partly to fusion of adjacent sacs but also to formation of subsidiary or secondary pouches.

Diverticula sometimes are placed so closely together that, as they enlarge, they coalesce, but usually the line indicating the junction of the two is apparent. Usually one of these is much larger than the other, so that ultimately the smaller may appear merely as a bulge on the larger. In some cases a secondary bulge is found towards the fundus of the diverticulum (Fig. XII), and such can be explained as a secondary formation rather than as due to fusion of two diverticula.

Specimens injected with opaque material have been examined radiologically (Rosedale and Lawrence 1936, Schmidt and Guttman 1934). This method, if only a small amount of opaque material is used, can be employed to show small pouches and their general conformation. In the living the general size and shape of diverticula may be shown clearly (Devegney and Bailey, 1942).

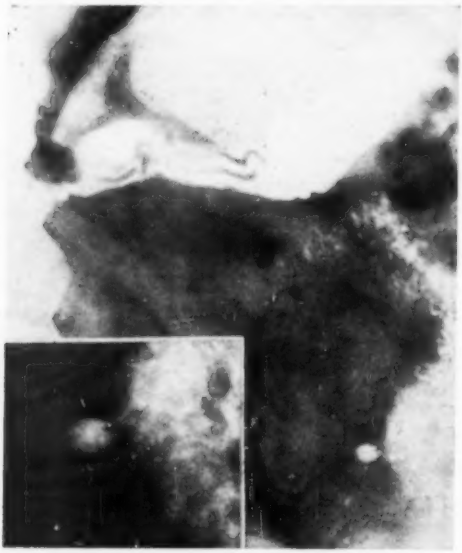


FIG. XIII. X-ray photograph shewing a small amount of barium in the intestine (stomach has been refilled), and there is a small diverticulum apparent. This is shewn in greater detail in insert. The patient was a male aged 72 years.

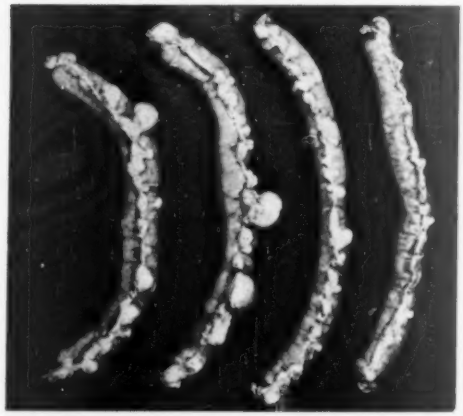


FIG. XIV. Photograph of loops of jejunum from a male aged 65 years. The mesentery has been removed almost completely and the intestine is viewed from the mesenteric aspect. Upper loops are on the left. The projection of many, if not most, of the diverticula to one side is apparent though in the lower portion (on right) there are some on both sides.

Site:

The majority of the diverticula is found at or near the mesenteric border. Those on the border project into and separate the two layers of the mesentery. However, in the upper part of the jejunum, the diverticula project more to the right side, *i.e.*, anteriorly (Berry, 1927). In addition, the diverticula which arise near but not at the mesenteric attachment, develop on the right rather than the left side of the gut (Fig. XIV). It should be emphasized that this right sided occurrence only applies fairly constantly to the upper part, and it is associated with the usual left sided position of the upper jejunal loops.

In the lower part of the bowel, diverticula are to be found arising from the bowel on both sides of the mesentery. This asymmetrical development is possibly to be correlated with the asymmetrical arrangement of the upper part of the small bowel in relationship to the mesentery. That the mesentery usually appears to be attached to the left or posterior aspect of the jejunum, as it lies in the abdomen, is a readily observed phenomenon (Fig. XV).

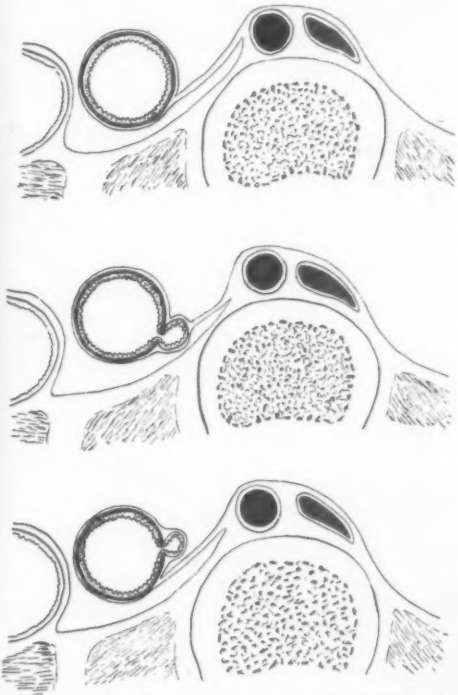


FIG. XV. Drawing shewing a common position of the upper loops of jejunum. Since the posterior part is supported, when bulging occurs this is more likely to occur from the right leaf of the mesentery or from the bowel on this side of the mesentery.

The precise site of origin of diverticula can be determined most easily and with greatest certainty in the case of small structures. These are seen to arise at various distances from the mesenteric attachment (Fig. XIV). The variability of this distance does not appear to depend on the position in the jejunum nor has any constant accompaniment been observed.

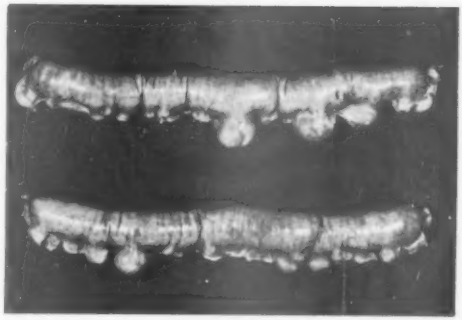


FIG. XVI. Photograph of pieces of intestine (Cf. Figs. XIV and XXIII) viewed from the side shewing variation in size of diverticula.

In the lower part of the jejunum and upper part of ileum where they occur on both sides of the mesentery, two such may be in close proximity, but they have not been found at all commonly directly opposite each other as described by Edwards (1934).

A minority of diverticula arises and is found well away from the mesenteric attachment; clear cut examples are described in the literature (Rudder, 1943). These vary greatly in size and in the sharpness of their demarcation from the adjacent gut. Gradations are found between localised "pouching" of the wall and diverticula with relatively narrow necks.

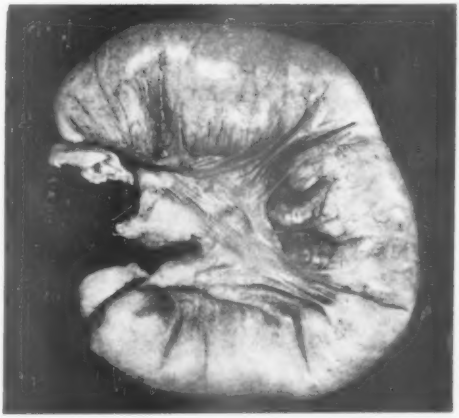


FIG. XVII. Photograph of a loop of jejunum from a female aged 23 years. The vessels are to be seen running at the side of the diverticula.

Relationship to Vessels:

A vascular bundle (artery and vein) is found closely related to each diverticulum. This runs from the mesentery over the surface of the diverticulum to enter the bowel wall. Sometimes it runs over the middle of the diverticulum, but frequently it is to one or other side of it. There is no constant relationship between the diverticulum and the vessels except their general propinquity.

When the diverticulum is at a distance from the mesentery, the vessels are also prominent and run from the mesentery over the bowel wall and then over the diverticular wall. When this occurs with a diverticulum at some distance from the mesenteric attachment it presents a striking appearance.

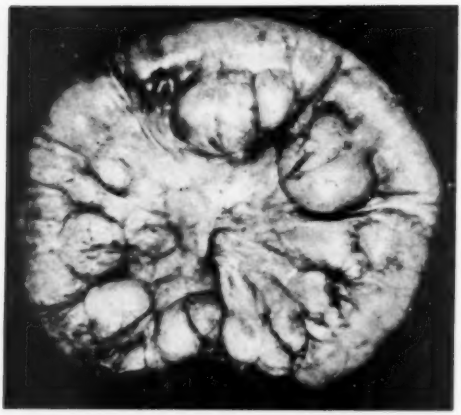


FIG. XVIII. Photograph of a loop of jejunum from a male aged 70 years shewing diverticula of various sizes. Vessels are seen running over the surface of some of the diverticula.

The relationship to vessels has been given much prominence since Klebs (1869) drew attention to it, and many of the hypotheses of the mode of development of these structures depends on this. There are, however, some features which deserve notice:

(i) Examination of a piece of bowel shows that any swelling at the mesenteric border, as it enlarges, necessarily must come into relationship with some or other vessel; (ii) since the prominence of vessels running to diverticula situated away from the mesenteric margin is not found elsewhere on the wall, it seems probable that this prominence is a result (or develops *pari passu*) rather than a cause; and (iii) the assumption that the vessels cause a weakness of the wall is fallacious because the diverticula are not herniae of the mucous membrane. This is discussed later.

The Walls of Diverticula:

The walls of multiple and the single examples found in adults are, in general, thin. However, their thickness is related mainly to their size. The smaller diverticula have thicker walls (Helvestine 1924, Butler 1933), and histological examination shows that they have muscle tissue in the wall corresponding to the coats of the intestine (Moore, 1883).

FIG. XIX. Photomicrograph of a small diverticulum (male aged 65 years) in which a thin layer of muscle is still present in the wall. (x 10)

The larger diverticula do not show muscle tissue, the wall consisting of mucous membrane and connective tissue (Fig. XX). Intermediate examples can be shown to have a few strands of muscle tissue running over their surface, so that the disappearance of muscle seems to be a gradual process associated with distension of the sac.

This occurrence of muscle in the walls of smaller diverticula not only indicates (as stated above) the futility of a distinction

between "true" and "false" types, but also disposes of hypotheses of origin that depend on a weakness of the muscle coat at the site of entrance (or emergence) of vessels through which mucous membrane could herniate.

FIG. XX. Photomicrograph of a diverticulum from a female aged 59 years. The muscle coat of the bowel is of normal thickness but the diverticulum has only a thin wall of fibrous tissue outside the mucosa. (x 4)

The difficulty of demonstrating jejunal diverticula by X-ray examination has an important bearing on the nature of the wall. Until recently these diverticula were demonstrated but rarely (Jenkinson 1929, van Ravenswaay and Winn 1943). It is necessary to examine the patient within a relatively short interval, during which the opaque material is still in the diverticulum, and this is not much longer than the time that it is in the small intestine itself. It is clear, therefore, that even if muscle tissue be lacking there must be sufficient elasticity of the wall to cause evacuation of the sac contents into the intestine. This is of importance in ensuring their freedom from complications.

Fat tissue is found in the subserous layer of the diverticula. In the case of the mesenteric types this may be regarded as an extension of the fat of the mesentery, but it is found also in those sacs which are away from the mesenteric attachment. The fat usually occurs as a thin layer, but this is greater in amount in the immediate vicinity of vessels.

Communication with the Bowel Lumen:

This opening is usually large, so that there is a free communication with the lumen of the gut. It is relatively large in small sacs, but even in the larger ones it is widely open.

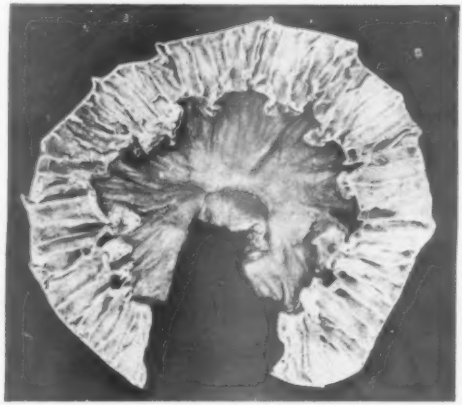


FIG. XXI. Photograph of a loop of jejunum (the same as in Fig. I) opened to demonstrate the relationship of diverticular cavities to the bowel lumen. The incision line is a little away from the mesenteric attachment.

In a few cases, with increasing size, the diverticulum becomes separated somewhat from the bowel wall, and a neck, which becomes narrowed as it elongates, is produced. This sometimes happens with sacs developing in antenatal life, and such examples constitute connecting links between diverticula and some mesenteric cysts.

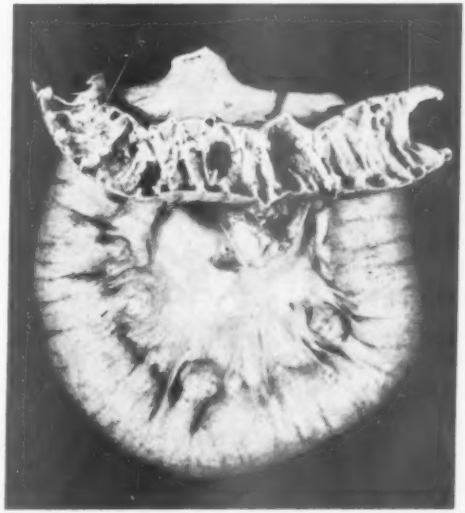


FIG. XXII. Photograph of loops of jejunum from a male aged 57 years. The position of the openings (not corresponding exactly to the mesenteric line) is shewn.

When viewed from the interior of the gut, the majority of openings is seen to be large, and though they may lie at the mesenteric attachment, more frequently they are a little to one side. In the lower part of the jejunum they may occur in pairs, one on each side of the mesenteric attachment, but careful observation shows that they are not opposite each other but are placed alternately.

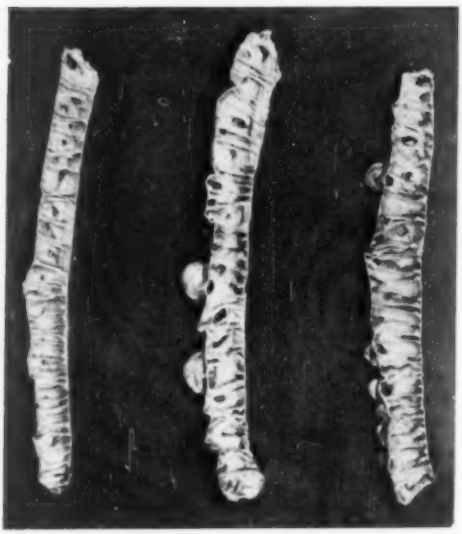


FIG. XXIII. Photograph of pieces of jejunum opened to be viewed from the mucosal aspect (Cf. Figs. XIV and XVI). Upper loops of jejunum are on the right hand side. Most of the openings lie to one side of the mesenteric attachment.

Contents:

The contents of diverticula necessarily conform with that of the intestine. This is usually fluid, so that the sac's content changes continually and stasis occurs seldom. This is demonstrated readily by radiological examination, and, as stated, has an important bearing on complications.

Sometimes special contents are found. Concretions have been observed by Christ (1932), Renard and Bergeret (1921), Terry and Mugler (1921) and Watson (1924) amongst others. Food particles were described by Treves (1900) and bones by Ogleblina (1931). Parasitic ova were observed by Goinard and Courrier (1929) and Rosedale (1935).

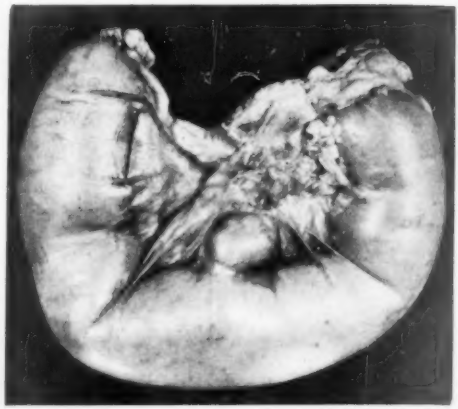


FIG. XXIV. Photograph of a loop of jejunum from a male aged 55 years, shewing some bulging of the wall adjacent to diverticula.

State of the Bowel Wall:

That there is an alteration in both the structure and functioning of the intestinal wall is shown in several ways.

i. The bowel wall in the immediate neighbourhood of diverticula, particularly the larger ones, is thinner than elsewhere and an appreciable bulge of the wall may be observed.

ii. Bulging of the wall, with formation of pouches, may occur at some distance circumferentially from, though in the vicinity of, the diverticulum. In the case of a mesenteric example the bulge may be on the antimesenteric border.

iii. There is sometimes a local dilatation of the whole of the gut in the proximity of diverticula. It is to be noted that this phenomenon — very obvious when the bowel is observed *in situ* — may disappear after manipulation, especially if it has been distended with fluid.

iv. A general distension of the bowel for some distance along its length in an area containing diverticula is sometimes prominent. The importance of this phenomenon is demonstrated by the clinical observation of "atony" of the gut as a cause of intestinal obstruction in some patients (Boling 1931, Fort 1921, McKechnie 1921, and Turner 1939). Many of the symptoms of abdominal pain and discomfort, colic and constipation are due

to this phenomenon and may disappear after treatment of the diverticulum (Johns, 1937). In what way this influences the bowel is not clear. In many of the cases described in the literature it is doubtful whether an obstruction was due, as stated, to the size of the diverticulum or to its containing a concretion. It seems much more probable, from what is known of the capacity of the bowel to propel fluid material past gross mechanical obstructions, that this "atony" of the gut is itself a more likely explanation.

Associated Conditions in the Bowel Wall:

A few examples of tissue hyperplasia have been found accompanying these sacs, either in their walls or in the adjacent intestine.

FIG. XXV. Photograph of a piece of jejunum (removed at operation because it was discovered as a symptomless mass) from a male aged 60 years. There is a large mass attached near the mesenteric border; it has a cavity communicating with the intestine (glass rod). Its cut surface is shewn. Cf. Fig. XXVI.

A lipoma has been described by Brandes (1929). Such a condition, a localised mass of fatty tissue, may be found in the wall of an otherwise normal intestine or in a Meckel's diverticulum. These do not show any progressive growth and are tumours only in that they are lumps of tissue. They should be regarded merely as excessive thickenings of the fatty layer described previously.

A fibroma has been recorded by Benson *et al.* (1943). The example shown here (Figs. XXV and XXVI) is an accumulation of fibrous tissue, the result of chronic inflammation and does not in any way, except by its size, suggest a neoplasm.

Aberrant pancreatic tissue has been observed by Edwards (1934), but since such occurs in the absence of diverticula, the association is only incidental.

A carcinoma developing in a diverticulum has been recorded by Edwards (1939, p. 166) and Benson *et al.* (1943), and in view of the relative infrequency of carcinoma of the small intestine, the association is worthy of remark as a pathological coincidence.

Sarcoma of the intestine such as described by Williams and Fodden (1946) is of doubtful significance. Proliferation of lymphoid tissue sometimes occurs with inflammation of diverticula, and this, both macroscopically and microscopically, may resemble a reticulo-sarcoma.

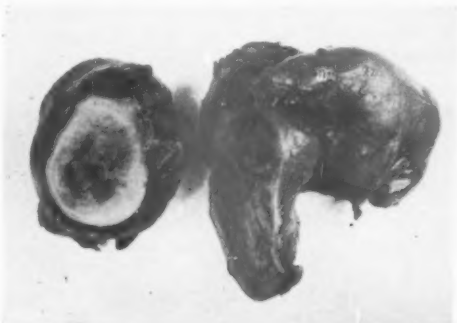


FIG. XXVI. Photograph of the specimen (Fig. XXV) viewed from the external aspect. The middle portion consisted of a fibrous "granulation tissue." The characteristics of the outer rim are shewn in section.

These various conditions are found with diverticula only rarely, either as the result of inflammation or a simple hyperplasia of unknown cause or as a chance association. They should be assessed critically because the careless use of some name (such as that of some neoplasm) will raise them to a potential clinical importance and significance which they neither deserve nor possess.

Complications:

The important complications are infection of the sac and its sequelae, traumatic rupture of a diverticulum and obstruction of the intestinal lumen.

Acute inflammation has been described by Beigler (1932), Edwards (1939), Fort (1921), Fraser (1933), Gournard and

Courrier (1929), Hubeney and Pollack (1938), Larson (1938), Simons (1928), Spackman (1926), Van Noort (1935) and Zagami (1937), amongst others. If the opening into the bowel be small or if there be mechanically or chemically irritating material in the sac, this complication is more readily understandable, but usually this is not the case. The presence of a concretion—as used to apply to the appendix—is seized upon to provide a mechanical type of explanation, but probably has no etiological influence in the development of infection. Examination of the bowel wall in cases of diverticulitis may show an acute inflammatory change in the mucosa, and thus a diffuse enteritis is probably the initiating factor. Once acute inflammation has begun, swelling of the tissues at the neck and changes in the sac contents will predispose to obstruction of its outlet, distension, and then further damage to the sac wall by the infecting agent.

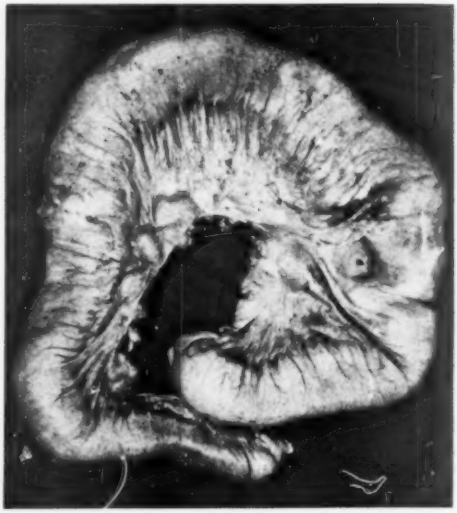


FIG. XXVIII. Photograph of a loop of jejunum removed at operation from a male aged 64 years. A perforation at the mesenteric attachment is apparent. Cf. Fig. XXIX.

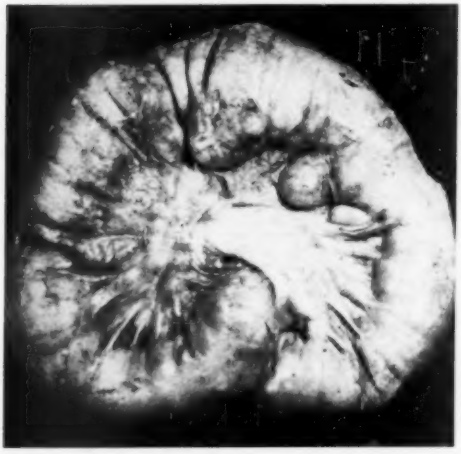


FIG. XXVII. Photograph of a loop of jejunum shewing typical diverticula. The patient, male aged 47 years, died of general peritonitis from a perforated peptic ulcer.

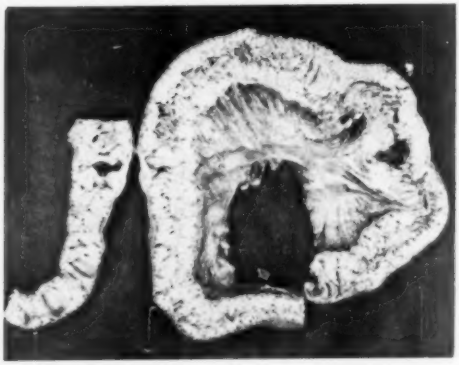


FIG. XXIX. Photograph of the loop of jejunum shewn in Fig. XXVIII; here seen in section. The diverticulum with a "concretion" is shewn. Several other diverticula were present, but in the collapsed bowel are not apparent. In the piece of bowel on the left side sacculations between valvulae conniventes are obvious.

Abscess formation occurs by spread of the infection through the wall, the infection remaining more or less localised (Butler 1933, Dodson 1941, Koletsky 1941, Walker 1945).

Peritonitis occurring as a diffuse spread of the infection from the sac has been observed by Butler (1933), Gerster (1933), and Ovens (1943).

Perforation of the sac occurs usually near its fundus, and when the sac lies in the mesentery the perforation occurs through one layer of the mesentery near its attachment to the gut (Fig. XXVIII). Such perforation has been observed by Benson *et al.* (1943), Christie (1922), Flynn (1933), and Treves (1900).

Haemorrhage from the region of the sac has been observed and may be indicated clinically by haematemesis (Braithwaite 1923), Guthrie and Hughes (1937) or by melaena (Tengwall 1931, Somerford 1930).

Thickening of the bowel may occur as the result of chronic inflammatory change, but this must be distinguished from the muscle hypertrophies associated with neuro-muscular inco-ordinations. These thickenings (Larson, 1938) may be found in cases of obstruction of the gut which are discussed below.

Traumatic rupture, following a blow on the abdomen, *e.g.*, a kick of a horse, has been described by Adams-Ray (1938), Butler (1937), and Schunk (1939).

Obstruction of the small intestine presents, in many cases, a difficult problem. In one group of cases the nature of the obstruction is well-defined, but in the other the nature of the obstruction is obscure.

Mechanical block may be due to any of the causes which produce intestinal obstruction. Thus, examples due to scarring and adhesions (Buchwald and Janicke 1887, Gordinier and Sampson 1906, Hubeney and Pollack 1938, Kaspar 1926, Neumann 1913 and Verster 1937), a kinking of the gut (Fraser, 1933), a band (Dodson, 1941) or a volvulus (Gladtke 1930, Godard *et al.* 1932) have been described. A remarkable example in which two diverticula were interlocked is recorded by Stiven (1934). The mode of production of a volvulus is probably similar to that of twisting of viscera, cysts or loops of bowel in other circumstances, the diverticulum (perhaps filled with material) constituting a mass which renders a loop mechanically unstable, so that any defor. ing stress may cause a rotatory motion which, once begun, continues sufficiently to occlude the lumen. In some cases, as in the two examples of the present series, the strangulation of the gut occurred at a distance from, and had no apparent relationship to, the diverticula.

Attempts are made, in almost all the cases recorded, to adduce some mechanical factor as the cause of the obstruction. The presence of a concretion in the sac (Christ 1932, d'Abreu 1944, Terry and Mugler 1921, Watson 1924) has been assigned as cause, but many of the descriptions fail to convince. This applies also to some of the adhesions, kinks and inflammatory changes in the wall, and this brings us to the non-mechanical form.

The second group, which can be designated adynamic, is exemplified by many of the examples described in the literature. The gut is distended and "atonic" and no definite obstruction has been found. It seems probable, as just suggested, that in a considerable number of cases where concretions, adhesions and the like have been observed, these are associations rather than etiologically effective conditions.

The importance of distinguishing between these forms and emphasising this adynamic or atonic type of obstruction is that it indicates the nature of the process giving rise to diverticula.

AETIOLOGY.

Many aetiological factors have been described to account for these conditions.

In the first place the diverticula occurring in early life have not been considered seriously. The statement that they are "congenital" has been accepted as being self-explanatory. It is necessary to appreciate that, while the investigation of the nature of antenatal pathological processes is difficult, it must nevertheless still be attempted, and in the meantime we must realise that the use of some magic word does not give us the key to this unknown territory.

Lewis and Thyng (1908) found diverticula in embryos of various kinds. This shows that outpouching of the wall of the gut may occur at different stages of development, but this gives no clue to the factors causing it nor does it necessarily have any bearing on those which develop in adults. We are beginning to understand something of the factors which determine developmental variations, *e.g.*, some cardiac malformations, but as yet there is no clue to those causing antenatal diverticula.

The adult types have been considered to arise from various causes — "congenital" factors, from special anatomical features in the wall (especially the blood vessels), from

certain changes assumed to occur in the vessels, and lastly from degenerative changes in the intestinal wall.

i. Only passing mention is required of the fact that the condition is not inherited, nor is there any recognized peculiarity which can be related to intra-uterine life. It is clear that most diverticula arise after the age of 40 years and the maximum incidence is in the seventh decade. The uncommon forms in young people are "acquired" in origin, but the factors governing their formation are unknown.

ii. The relationship to vessels, since it was noted by Klebs (1869), has continually attracted attention. The various hypotheses, based on this relationship, have been discussed by many writers, and especially Beer (1904) and Fraser (1933), so they need not be elaborated here. They depend on the idea that the place where the vessels pass through the muscle wall is necessarily weak. In some instances special distension of the vessels (congestion) has been postulated to account for widening of this potential gap with more obvious weakness.

All of these hypotheses are disposed of by the observation that the small diverticula have muscle in their walls. If they developed as a herniation through a weak area of the wall they should be of the "false" type from their inception.

The association of a well-defined vessel with each diverticulum is a uniformly demonstrable phenomenon, but does not necessarily have any etiological significance. The irregular anatomical relationship of vessels to diverticula suggests a mere accidental association (discussed previously). The difficulty of showing experimentally a weakness of the mesenteric part of the intestine and the peculiar prominence of vessels running to sacs at a distance from the mesentery, all indicate that the idea of some vascular peculiarity being primarily responsible is too superficial a view. It is much more probable that the vessels occupy their position and become prominent as a secondary phenomenon, comparable with the increase observed in either hypertrophied or inflamed structures. The presence of fat in the wall of many of the diverticula (including those away from the mesentery) supports this idea.

iii. The idea of "weakness" of the bowel wall is supported by several observations. The simultaneous occurrence of diverticula in other parts of the alimentary canal, in the bladder and the presence of herniae of the abdominal wall suggest a general tissue weakness. Distension of the intestine in the neighbourhood of diverticula indicates a definite difference of this part from other parts of the bowel. It is emphasised that this relaxation and pouching may be in any part of the wall, thus refuting the notion of special anatomical sites.

Passive distension of segments of the gut by fluid, even with high pressures, shows that there is no weak area at the mesenteric attachment. No pouchings can be produced in this manner, and though these results are not necessarily comparable with the effects of long maintained pressures, such observations should not be ignored.

The majority of diverticula does occur, however, in a segment of the bowel near the mesentery. When the bowel distends, the swelling occurs into the mesentery (Fig. XXX), so that the part of the wall which has the greatest amplitude of structural variation is in this region. It is probable that for this reason, though not demonstrable in "acute" experiments, this part of the gut is affected more than other parts by chronic stresses and special stimuli when the wall is weakened. Whether this be the true explanation the diverticula do occur in this zone.

The general proposition is that the intestinal wall has become weakened, and this is shown both by local pouchings and diverticula and also a more diffuse dilatation. This has been regarded as a "degeneration," "weakness" or "wearing out" of the muscle due to old age. This could be the result of vascular disease occurring in old age. This general view is supported by the age incidence, but since the condition occurs in so few individuals some more specific factor than "weakness from old age" or even vascular disease must be sought.

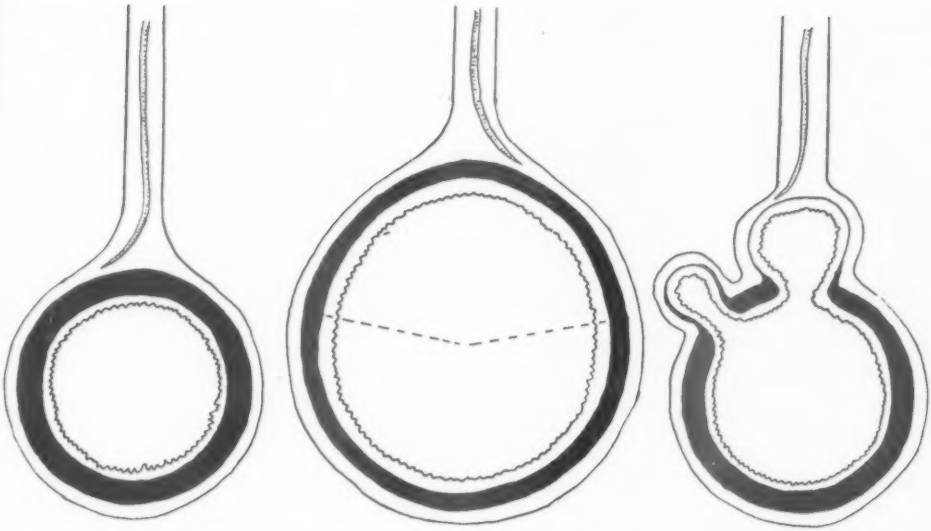


FIG. XXX. Drawing to shew the way in which distension occurs into the mesentery. The mesenteric half of the intestine is the part in which, provided the peritoneal coat remains intact, most strain will be placed on the wall. Thus if the wall be weakened to sufficient degree, mechanical factors will determine this site of formation of pouchings and thus diverticula.

When we consider similar changes in muscle elsewhere (ureter and blood vessels) we are faced with two hypotheses; (i) that such changes are due to neuromuscular incoordination (Hirschsprung's disease, hydroureter and hydronephrosis); and (ii) that they are due to chemical substances usually, in our present experience, hormones (hydroureter in pregnancy, some varicosities, telangiectases, etc.). Whether these two are interrelated, *i.e.*, chemical factors act by way of the nervous system, is not known.

We have insufficient evidence on which to base a complete hypothesis, but the demonstrable features suggest an active inhibitory change in the bowel wall of one or other of the types just mentioned. This is in some manner related to diverticulum formation. This relaxation of the wall, obviously noted by the older writers, constitutes the "degeneration," "loss of tone," or "muscle weakness" postulated by them. What we have still to find is the factor responsible for this change in the tissues of the bowel wall.

Mechanical factors such as increased pressure within the gut have not been considered here since both experimental and clinical evidence indicates that this cannot be of primary importance. When the wall has become weakened, however, as shown by the unilateral development in the upper jejunum, mechanical factors play an important even if subsidiary part.

SUMMARY.

1. A small series of 32 post-mortem specimens and 5 obtained at operation form the basis of a description of the features of diverticula of the small intestine.

2. The literature is extensively but by no means exhaustively reviewed.

3. The diverticula are much more common than is generally thought.

4. They are frequently associated with local or more extensive but regional balloonings of the adjacent intestine, and this association is regarded as etiologically significant. Thus the essential feature is the development of a muscle weakness the origin of which is discussed. Anatomical factors do not provide an adequate explanation for the formation of the diverticula.

5. Symptoms occur with some diverticula, and these are due usually to this distension or "atony" of the gut wall.

6. Complications are unusual but should be sufficiently well known to be recognized when they do arise.

ACKNOWLEDGEMENTS.

For the specimens of the diverticula in children I am indebted to Dr. R. Webster. The specimen of the large chronically inflamed diverticulum was obtained from the Department of Pathology, University of Melbourne. I would express my appreciation of the care in preparation and dissection of most of the specimens by Dr. G. S. Christie, Assistant Pathologist, Royal Melbourne Hospital. Most of the photographs were produced by Mr. R. Inglis, Clinical Photographer, Royal Melbourne Hospital. The X-ray photograph is used by the courtesy of Dr. Keith Hallam.

REFERENCES.

ADAMS-RAY, J. (1938), *Acta chir. Scandinav.*, vol. 81, page 398.

BAASTRUP, C. I. (1924), *Acta Radiol.*, vol. 3, page 164.

BEER, E. (1904), *Amer. J. Med. Sc.*, vol. 128, page 135.

BEIGLER, S. K., BLOOM, A. R., and WRUBLE, J. (1932), *Amer. J. Surg.*, vol. 17, page 109.

BENSON, R. E., DIXON, C. F., and WAUGH, J. M. (1943), *Ann. Surg.*, vol. 118, page 377.

BERRY, J. A. (1927), *Lancet*, vol. 2, page 496.

BOLING, J. R. (1931), *J. Amer. Med. Assoc.*, vol. 96, page 526.

BRAITHWAITE, L. R. (1923), *Brit. Med. J.*, vol. 2, page 184.

BRANDES, K. (1929), *Dtsch. Z. Chir.*, vol. 215, page 390.

BUCHWALD, A., und JANICKE, O. (1887), *Dtsch. Med. Wschr.*, vol. 13, page 868.

BUTLER, R. W. (1933), *Brit. J. Surg.*, vol. 21, page 329.

—— (1937), *Ibid.*, vol. 25, page 277.

BUZZI, F. (1885), *Arch. path. Anat.*, vol. 100, page 357.

CASE, J. T. (1920), *J. Amer. Med. Assoc.*, vol. 75, page 1463.

CHAPMAN, J. (1934), *Ann. Int. Med.*, vol. 7, page 1376.

CHRIST, A. (1932), *Dtsch. Z. Chir.*, vol. 235, page 560.

CHRISTIE, G. W. (1922), *Brit. Med. J.*, vol. 1, page 990.

COOPER, ASTLEY (1807), "Anatomy and Surgical Treatment of Crural and Umbilical Hernia." London, page 87.

CORNILLON (1869), *Bull. Soc. Anat. de Paris*, vol. 44, page 525.

D'ABREU, F. (1944), *Brit. J. Surg.*, vol. 31, page 408.

DEVEGNEY, F. E. C., and BAILEY, H. (1942), *Brit. Med. J.*, vol. 2, page 98.

DODSON, R. M. (1941), *West. J. Surg.*, vol. 49, page 143.

EDEL, M. (1894), *Arch. path, Anat.*, vol. 138, page 347.

EDWARDS, H. C. (1934), *Lancet*, vol. 1, page 169.

—— (1936), *Ann. Surg.*, vol. 103, page 230.

—— (1939), "Diverticula and Diverticulosis of the Intestine," Bristol. John Wright & Sons.

EVANS, A. (1929), *Brit. J. Surg.*, vol. 17, page 34.

FLYNN, R. (1933), *Aust. N.Z. J. Surg.*, vol. 3, page 192.

FORT, F. T. (1921), *Kentucky Med. J.*, vol. 19, page 208.

FRASER, I. (1933), *Brit. J. Surg.*, vol. 21, page 183.

GERSTER, J. C. A. (1938), *Ann. Surg.*, vol. 107, page 783.

GISBERTZ, H. (1931), *Arch. klin. Chir.*, vol. 165, page 314.

GLADTKE, M. (1930), *Dtsch. Z. Chir.*, vol. 224, page 345.

GODARD, H., BOURDIAL, and ZOUREKATIS, TH. (1932), *Ann. Anat. path. med.-chir.*, vol. 9, page 311.

GOINARD, P., and COURRIER, R. (1929), *Ann. Anat. path. med.-chir.*, vol. 6, page 189.

GORDINIER, H. C., and SAMPSON, J. A. (1906), *J. Amer. Med. Assoc.*, vol. 46, page 1525.

GLANS, A. (1920), *Schweiz. med. Wschr.*, vol. 50, page 1024.

GUTHRIE, D., and HUGHES, F. A. (1937), *Surgery*, vol. 1, page 595.

HANSEMAN, D. (1896), *Arch. path. Anat.*, vol. 144, page 400.

HEIDECKER, H. (1928), *Beitr. klin. Chir.*, vol. 142, page 776.

HELVESTINE, T. J. (1924), *Surg. Gynec. Obstet.*, vol. 37, page 1.

HUBENEY, M. J., and POLLACK, S. (1938), *Amer. J. Roentgenol.*, vol. 40, page 689.

HUNT, E. L., and COOK, P. H. (1921), *Ann. Surg.*, vol. 74, page 746.

HUNTER, J. I. (1922), *Brit. Med. J.*, vol. 2, page 800.

JENKINSON, E. L. (1929), *Radiology*, vol. 12, page 100.

JOHNS, F. S. (1937), *South. Med. & Surg.*, vol. 99, page 265.

JOHNSON, E. A. (1906), *Aust. Med. Gaz.*, vol. 25, page 633.

KASPAR, F. (1926), *Arch. klin. Chir.*, vol. 141, page 389.

KEITH, ARTHUR (1910), *Brit. Med. J.*, vol. 1, page 376.

KLEBS, E. (1869), *Handb. path. Anat.*, Berlin: A. Hirschwald, vol. 1, page 271.

KOLETSKY, S. (1941), *Ohio St. Med. J.*, vol. 37, page 1078.

KOZINN, P. J., and JENNINGS, K. G. (1941), *Amer. J. Dis. Child.*, vol. 62, page 620.

LARSON, E. M. (1938), *West. J. Surg.*, vol. 46, page 127.

LEWIS, F. J., and THYNG, F. W. (1908), *Amer. J. Anat.*, vol. 7, page 505.

MACKECHNIE, H. H. (1921), *Ann. Surg.*, vol. 73, page 135.

MCMURRICH, J. P., and TISDALL, F. F. (1928), *Anat. Rec.*, vol. 39, page 325.

MECKEL, J. F. (1822), *Tab. Anat. Path.*, fasc. 3, tab. 23.

MOORE, N. (1883), *Brit. Med. J.*, vol. 2, page 920.

NEUMANN, A. (1913), *Dtsch. Z. Chir.*, vol. 126, page 185.

OGLOBLINA, S. (1931), *Zentralbl. Chir.*, vol. 58, page 3169.

OSLER, W. (1881), *Ann. Anat. Surg.*, vol. 4, page 202.

OVENS, G. H. C. (1943), *Brit. J. Surg.*, vol. 30, page 239.

RANKIN, F. W., and MARTIN, W. J. (1934), *Ann. Surg.*, vol. 100, page 1123.

VAN RAVENSWAAY, A. C., and WINN, G. W. (1943), *Amer. J. Digest. Dis.*, vol. 10, page 108.

REINHARDT, (1926), *Zbl. Chir.*, vol. 53, page 1091.

RENARD, M., and BERGERET (1921), *Bull. Soc. Anat. de Paris*, vol. 18, page 220.

RITVO, M., and VOTTA, P. J. (1946), *Radiology*, vol. 46, page 343.

ROSEDALE, R. S. (1935), *Surg. Gynec. Obstet.*, vol. 61, page 223.

ROSEDALE, R. S., and LAWRENCE, H. R. (1936), *Amer. J. Surg.*, vol. 34, page 369.

ROTHSCHILD, N. S. (1925), *Ann. Surg.*, vol. 82, page 250.

RUDDER, F. F. (1943), *Surgery*, vol. 14, page 921.

SCHMIDT, E., and GUTTMAN, P. H. (1934), *Amer. J. Roentgenol.*, vol. 31, page 200.

SCHUNK, P. M. (1939), *Rocky Mountain Med. J.*, vol. 36, page 327.

SEIPPEL, O. (1895), *Inaug. Diss. Zurich*, page 21.

SHEPPE, W. M. (1924), *J. Amer. Med. Assoc.*, vol. 82, page 1118.

SIMONS, E. J. (1928), *Minnesot. Med.*, vol. 2, page 752.

SOMERFORD, ANNE E. (1930), *Lancet*, vol. 1, page 1015.

SPACKMAN, J. G. (1926), *Ann. Surg.*, vol. 84, page 778.

STIVEN, H. F. S. (1934), *Lancet*, vol. 2, page 704.

TENGWALL, E. (1931), *Acta Chir. Scandinav.*, vol. 68, page 162.

TERRY, W. H., and MUGLER, R. R. (1921), *Arch. Surg.*, vol. 2, page 347.

TREVES, F. (1900), 'Intestinal Obstruction: Its Varieties with their Pathology, Diagnosis and Treatment." London. Page 565.

TURNER, P. (1939), *Guy's Hosp. Rep.*, vol. 89, page 32.

VAN NOORT, D. W. (1935), *Ned. Tijdschr. Geneesk.*, vol. 79, page 5232.

VERSTER, R. S. (1937), *Sth. Afr. Med. J.*, vol. 11, page 838.

WALKER, J. M. (1945), *Brit. J. Surg.*, vol. 32, page 457.

WALLMAN, H. (1858), *Arch. path. Anat.*, vol. 14, page 202.

WATSON, C. M. (1924), *Surg. Gynec. Obstet.*, vol. 38, page 67.

WILLIAMS, A. G., and FODDEN, J. H. (1946), *Brit. J. Surg.*, vol. 34, page 57.

ZAGAMI, A. (1937), *Policlinico*, vol. 44, page 550.

ZENGERLE. Quoted by KASPAR (above).

GRAFTING OF HOMOGENOUS BONF AND CARTILAGE.

By H. K. Christie.

Wanganui.

Introduction.

THE first cartilaginous transplant in animals is said to have been carried out by Bert of Paris in 1865 and the first autogenous human graft of cartilage by Koenig in 1896 (Brown and De Mere, 1948). The first human bone transplant was done by Macewan in 1878 (Bush, 1947) and the first bone bank is attributed to a British hospital in World War II (Henry, 1948).

The rapid progress in this subject since then has been made possible by the advances in the ancillary sciences such as metallurgy, chemotherapy, refrigeration and animal experimentation. The twin questions of bone and cartilage grafting are considered together because of their closely related problems and of their complementary value.

The principles of grafting in the plant world have long been understood and practised. It is possible to graft related plants to one another, and where the host and donor are of the same family, they are said to be syngenesious, a term now applied also in human bone grafting where bone is transferred between close relatives in the same family (Bush, 1947).

Transplantable tissues.

So far as animal tissues are concerned, the limits to which grafting is possible have been constantly extended by improvements in method and equipment. Blood, fat, skin (both dermis and epidermis) cornea, peritoneum, vein, peripheral nerve, tendon, fascia, cartilage and bone can all be grafted. Young grafted cartilage has been found to retain its inherent property of growth (Dupertius, 1941; Peer, 1946). Blood, cartilage, bone, tendon, fascia, fat and dermis are all mesenchymal connective tissues with the same type of cellular element — the fibroblast. Their properties differ because of their differing intercellular substance. Epidermis and peripheral nerve, on the other hand, are of epidermal origin.

Whilst all these grafts tend to retain their original structure, Peer (1944) believes that the only two which maintain complete survival are epidermis and cartilage. Bone and fat grafts undergo partial absorption and replacement. Inclan (1942), however, states that, clinically, refrigerated homografts act like fresh autogenous bone, whilst the histological appearances "vary little or not at all from fresh bone".

Experiments have been made in the transplantation of whole joints (Lexer, 1925 and 1935; Meyer, 1931; Bunnell, 1948). Both Key (1940) and Bankart (1945) have made successful autografts of epiphyses. Improved methods may yet lead to further success and even the transplantation of the reproductive cells may be accomplished.

Nomenclature.

Campbell (1949) has devised a nomenclature to describe the various types of graft. Bone in general is either cortical or cancellous. Cartilage is either hyaline, white fibro-cartilage, or yellow elastic cartilage. In each case the graft may be autogenous (autograft), homogenous (isograft) or heterogenous.

1. The graft is autogenous when the patient is his own donor.
2. It is homogenous when it is obtained from a human donor other than the patient. A homogenous graft is also syngenesious or "syngenesio-plastic" when taken from an immediate relative. A homogenous graft may also be called cadaveric when taken from a cadaver or from an amputated limb.
3. A graft is heterogenous if taken from another species, e.g., beef bone. Such grafts are no longer used. They act merely as internal splints and may excite a reaction and undesirable sequelae (Orell, 1937; Campbell, 1949).

Precautionary tests of donor.

There are certain precautions to be observed in accepting homogenous grafts. The donor must be free from disease. Syphilis, yaws, malaria, bone disease, bacteriaemia, tuberculosis and carcinoma must be excluded by history and appropriate tests (Turner, 1938). The blood group and Rh factor, however, are not of importance because little blood is transferred with the graft.

Value of homogenous grafts.

Recent work shows the value of homogenous grafts. Bush (1947) at the New York Orthopaedic Hospital used homogenous bone in 67 operations with only 4 complications. Aldridge (1948) had 13 successful cases out of 15 transplants. Other workers have had similar experiences. The homogenous graft in itself has certain advantages:

1. In young children both quality and quantity of bone at the donor sites may be lacking. Damage may be done to an epiphysis in taking a graft from a child, or growth may be disturbed. Shock must be minimized in operating on children.
2. In certain bone diseases, e.g., *fragilitas ossium*, Paget's disease and osteoporosis, bone from another individual is to be preferred.
3. In debilitating diseases, e.g., tuberculosis of the spine, it is important to reduce operating time, shock and loss of blood.

The bone bank.

If for any reason grafts are not to be used fresh, they must be stored. This was originally done by temporary implantation in the subcutaneous tissues of the host. Refrigeration has now superseded this method. The familiar blood bank of the last War has become the parent of a whole family of banks — cartilage (Brown and De Mere, 1948), bone (Bush, 1947), skin (Webster, 1944; Strumina and Hodge, 1945; Matthews, 1945; Baxter and Entin, 1948) and vein banks (Murray, 1940; Blakemore, Lord and Stefko, 1942, 1943; Blakemore and Lord, 1945; Blakemore, 1946; Mason Brown, 1948).

The methods of storage may be described as either "dry" or "wet".

A. Dry storage.

Dry storage is likely to become universal, on account of its simplicity and long storage potentiality.

This is the method which has been established at the New York Orthopaedic Hospital. Two terms are used, "regular refrigeration" and "deep-freezing storage" (Bush, 1947).

Regular refrigeration is used for short-term storage up to three weeks. The bone taken during operation is placed in a small sterile bottle with a screw cap. This is then enclosed in a larger sterile container which also has a screw top, and finally all are capped with a layer of gauze and rubber. Storage is made at a temperature of from 2 to 5 C.

Deep-freezing storage is used for indefinite periods. The graft in its double container is stored at a temperature of –25° C. It is allowed to thaw to room temperature before use, although this is not essential.

It has been shown that bone will survive the temperature of liquid air for fifteen minutes (Bush, 1947). This is in contrast with the behaviour of epithelium where temperatures below freezing point are considered unduly lethal (Baxter and Entin, 1948).

Each container is suitably labelled and a card-index is kept. The card shows the following details:—

Donor — name, number, source of bone, date of storage.

History — (jaundice, malaria, etc.). Blood tests: Kiine or Kahn.

Recipient — name, date, use of bone.

B. Wet storage.

This is the more usual method (Inclan, 1942) and has been employed in the cases recorded in this paper.

Whole citrated blood of any group or a mixture of this with saline (blood, 1 part, to saline, 4 parts) is used. The graft is completely covered by the solution. To one pint of this fluid may be added 200,000 units of penicillin and sulphathiazole .05 g.

in solution and the whole well stirred. The solution is changed and bacteriological tests are made once a month and immediately before use. As the grafts retain viability for a considerable time (the full period is as yet underdetermined) further bone may be added to the container if desired during the month's storage. Small increments from suitable operation cases will thus add up to a considerable amount of cancellous chips by the end of the month, and storage is simplified. The same solution is appropriate for either bone or cartilage.

(The bone or cartilage bank is in the care of a bacteriologist, who carries out the periodical tests. If penicillin and sulphadrugs have been utilized, the appropriate neutralizing compound will be required in cultures. In making the tests, both the graft, from which a small piece is snipped, and the supernatant fluid should be tested.)

The cartilage bank.

The cartilage bank is of earlier evolution than the bone bank. Plastic surgeons have used boiled cartilage or have preserved it in various solutions such as alcohol or Merthiolate. (Peer, 1944; Brown and De Mere, 1948). These methods antedate the days of penicillin and provide sterile but non-viable grafts. Where the cartilage is intended as a mould or scaffolding, however, viability does not matter because cartilage grafts will remain indefinitely in the tissues without being absorbed. (Kirkham, 1940; Firestone, 1946). Cartilage grafts will not survive dessication, but if stored under conditions similar to those of the bone bank, will retain viability for long periods.

O'Connor (1938, 1939) used a concentration of 1:1000 Merthiolate to four parts of sterile saline; but considerably greater concentration (1:100) has been used for sterilizing cadaver cartilage (Brown and de Mere, 1948). The solution is changed twice a week for two weeks and once a week thereafter. The stored grafts have been used after periods of two years in the solution. In a letter dated July 19th, 1949, Dr. O'Connor informs me that he still uses the refrigerated "Merthiolized" isografts in preference to autogenous cartilage.

Fate of the grafts.

Much work has been done on the fate of grafts. There are two possibilities for the successfully grafted material.

1. Complete survival. This has been shown to occur in fresh autogenous cartilage grafts, and probably often occurs with cancellous bone chips where a youthful donor and host are concerned, provided a good vascular bone bed is obtained (Mowlem, 1945). In the case of human subjects there is room for more information on this point.
2. Partial survival combined with a process designated by Phemister (1930), "creeping substitution," and by Axhausen (1908), "schleichender Ersatz." There is general agreement that osteoblasts, which may survive on the endosteal and subperiosteal surfaces, will continue their activity. Inclan (1942), who described the use of refrigerated bone grafts in 52 cases, has successful osteogenesis and union in 2 cases of fractured femoral neck at the age of "around 90 years".

This process of partial replacement by creeping substitution has been studied experimentally by a number of authors (Axhausen, 1908; Phemister, 1930; Young, 1945; Gordon and Warren, 1947).

The number of osteoblasts which survive depends on the speed with which revascularization of the graft occurs, and therefore it is an advantage to make the chips or shavings of bone or cartilage as small as possible. In the case of cartilage this is done by a process known as "dicing" whereby the cartilage is chopped into small cubes. A sharp, thin osteotome, a pair of bone nibblers, and a cheese-grater are all part of the armamentarium of the chip grafter.

Chip grafts.

Special properties are possessed by cancellous chip grafts. The chips are preferred from sites rich in red marrow rather than from places where the marrow contains much fat. Thus the crest of the ilium, the ribs, and tarsal bones are better than the upper end of the tibia. Mowlem (1945)

has pointed out three remarkable properties of cancellous bone chips:

1. They are resistant to infection. They may grow and re-vascularize even when the skin over them has not been fully joined together.
2. They show quick adaptability and capacity for remodelling. In tibial defects grafted with chips from the anterior superior spine Mowlem found that a new cortex was developed in from eight to twelve weeks.
3. They survive even when not in contact with other bone, e.g., when used for restoration of nasal contours.

Mowlem found that chip grafts for mandibular defects showed clinical consolidation in twenty-six days. Even in infected bone cavities the chip grafts gave rapid and certain results. The grafting was carried out in one or two stages.

An interesting refinement in technique was used by Sarjeant (1946) when restoring defects in long bones due to compound fractures. He bridged the gap between the bone ends by a centrally placed thin slice or prop of ilium, slotted into each end of the shaft. On both sides of this central platform he built up a complete filling of shavings or "stamps".

Other workers have used the method of chip grafting in conjunction with penicillin and sulphathiazole. (Abbot et al., 1946; Coleman et al., 1946.) The simplicity of this technique foreshadows a definite advance in bone grafting.

Cartilage chips show properties similar to those of the bone shavings. Resistance to infection is somewhat less (O'Connor and Pierce, 1938). Young, fresh cartilage grafts will increase in size; fresh grafts retain viability whilst dead cartilage resists absorption and remains in the tissues for indefinite periods.

Of considerable interest is the transformation of cartilage grafts into bone. Diced and grated cartilage has often been used to fill a bone cavity where weight bearing is not required (Peer, 1944). If the cavity is infected, bone chips are preferred (Mowlem, 1945; Coleman et al., 1946).

It is known that in many situations cartilage has a natural tendency to turn into bone, e.g., ossification in rib cartilage, loose bodies in joints, etc. Transplanted rib cartilages in experiments with dogs and rabbits showed a tendency to ossify and also to promote bone deposition (Young, 1945; Gordon and Warren, 1947). There is a useful field for observations in the human subject where a varying proportion of diced cartilage could be mixed with the cancellous bone chips and the degree of ossification attained noted with serial X-ray examinations.

There are certain methods of following the progress of the grafted bone in the human subject. Apart from clinical examination most observers have used radiography, operative re-examination (especially in staged spine grafts) and biopsies. The appearance of a successful homograft — even of cadaver bone — when re-examined at a later operation, is most impressive. Firmly fused with the host bone, and provided with a covering which to the eye is not unlike periosteum, the graft has the appearance of fresh bone. Biopsy of portion of it, however, will reveal that a process of partial substitution has occurred, the apparently intact cortex being, in fact, an aseptic sequestrum surrounded and replaced by new bone derived in part from the graft and in part from the metaplasia of invading connective tissue cells (Bush, 1947).

The homogenous type of graft, either bone or cartilage, is used, in general, wherever a considerable replacement is required. For "onlays" to bridge fractures and defects, for chip fillings to obliterate cavities, aseptic or otherwise, for spinal fusions and for many reconstructive procedures such as acetabuloplasty (shelf operation) and for ununited fractures of the femoral neck, the homogenous graft fulfils all requirements. Experimental work also appears to indicate that the cartilage homograft is suitable for cartilage cap arthroplasty of the hip-joint (Wagner, 1929; Brackett, 1938; Moore, 1948). Antibiotics and refrigeration have opened a new chapter in bone surgery.

CASE REPORTS.

Some case reports that follow illustrate the principles that have been enumerated in the text. In the grafting of infected bone cavities with cancellous chips by the one- or two-stage method, we have used a mixture

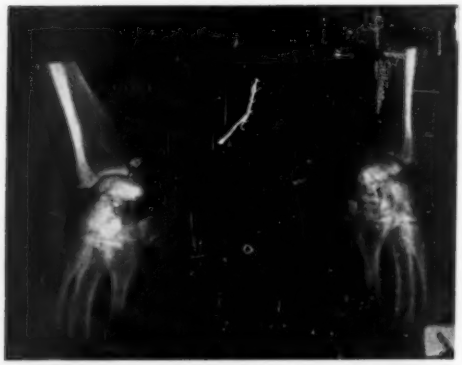


FIG. I.—Case 1: Film taken 3½ weeks after operation. The bone chips are still visible in the left scaphoid.

of sulphathiazole and penicillin in the proportion of 20 g. of sulphathiazole to 200,000 units of penicillin. The chips are lightly coated with this mixture just as a fillet of fish is coated with flour before being placed in the frying pan. Parenteral penicillin is also given for five days by any recognized technique. In some cases it was convenient to give a large dose (60,000 to 100,000 units) night and morning. Some writers contend that sulphonamides inhibit bone formation (Benesh, Chance and Glynn, 1945). This has not occurred in our limited experience, nor in that of most other observers. Further experience is required on this point.

Case 2 illustrates clearly the re-formation of the cortical layer of the humerus in a child aged 4½ years.

In Case 9 a tuberculous bone cavity in the head of the humerus was curetted and packed with cancellous chips. These have survived and become incorporated with the host bone.

In Case 3 an infected knee joint, from a compound fracture, was arthrodesed with cancellous chips and a large cavity in the lateral condyle of the femur later treated successfully in the same way, after preliminary skin covering had been obtained by means of a travelling tubed pedicle graft. This case is interesting as presenting the unfavourable combination of penicillin-resistant organisms and a sclerosed cavity in the bone. Streptomycin was used with success (10 c.c. four-hourly as a pack in the cavity for five days).

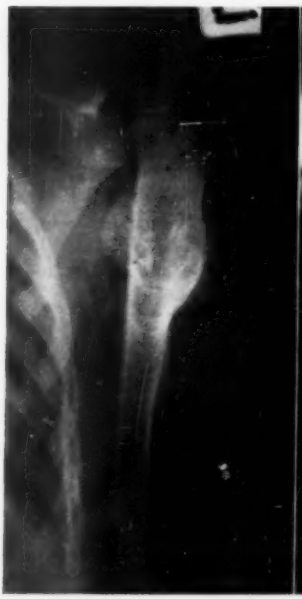


FIG. II.—Case 2: Antero-posterior view of exostosis.

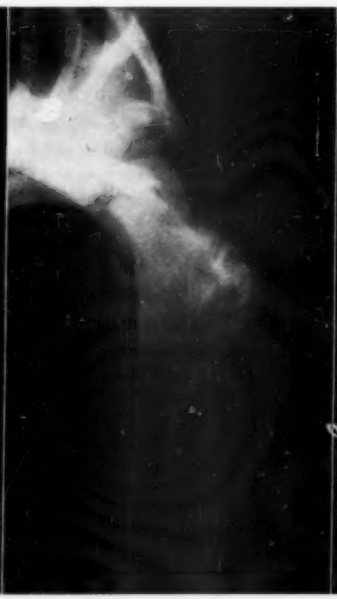


FIG. III.—Case 2: View of exostosis with the arm abducted and externally rotated.

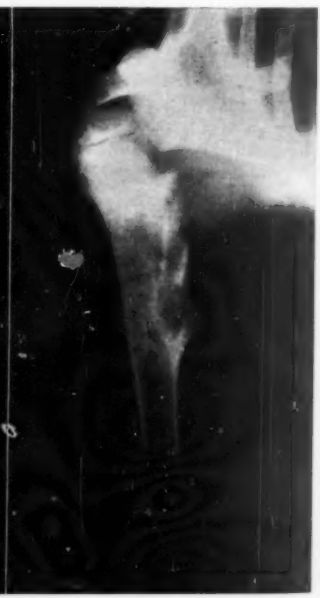


FIG. IV.—Case 2: The tumour has been removed and the defect packed with homogenous bone chips.

The use of cadaveric bone is illustrated in Cases 7 and 8.

Where tarsal bones were used as chips, no attempt was made to exclude the articular covering where this encroached on the bone chips.

In 3 cases (numbers 5, 7 and 8) there was successful cross grafting between Maori and white man.

Firestone (1946) reports the use, for nasal reconstruction in the white subject, of boiled rib cartilage taken three days after death from the embalmed bodies of a negro and a Japanese. It would be even more interesting if some of our American colleagues could ascertain the fate of living homografts of cartilage and bone between the white, black and yellow races.

Some bone-graft cases are listed in the following table:—

CASE 1.

R.J.E., male aged 39, who was admitted to hospital on Dec. 7th, 1948, had been working as an axeman for the previous ten years, sustained a "sprain" of the right wrist fourteen months previously whilst cranking a Diesel engine. About six weeks previously he began to get pain in the left wrist also.

Examination showed an advanced cystic condition of both carpal scaphoids with fracture through the left scaphoid.

A diagnosis of bilateral cystic disease of the carpal scaphoids with fracture on the left side was made.

Operation, Dec. 17th: Fragments of the left scaphoid were removed. The right scaphoid was drilled, curetted and the cysts packed, using fresh autogenous cancellous iliac bone chips (Fig. I).

Pathologist's Report. There is no evidence of fibrocystic disease, tuberculosis or other inflammatory condition. The cysts are traumatic in origin.

(Note: Traumatic cysts in carpal and metacarpal bones of this type have been described by Brailsford, 1948).

TABLE I.

Case	Pathological condition	Type of graft used	Remarks
1. Male, aged 39	Uninfected. Traumatic cysts of carpal scaphoids	Iliac bone; cancellous chips; fresh autogenous	No chemotherapy used. Rapid recovery and consolidation
2. Female, aged 4½	Uninfected. Large cartilaginous exostosis of left humerus	Tibial cancellous chips; homogenous, refrigerated	New cortex formed in eight weeks. Remodelling of shaft in ten weeks
3. Male, aged 19	Compound fracture of femur into knee joint with infected cavity and suppurative arthritis	Iliac bone; refrigerated autogenous chips	Two operations: (a) Arthrodesis of knee with cancellous chips; penicillin used. (b) Two-stage grafting of cavity with cancellous chips; streptomycin used
4. Female, aged 38	Infected ununited compound fracture of tibia with sequestra and cavity	(a) Refrigerated autogenous "callus" from fractured femur. (b) Homogenous block from ilium	Penicillin used. One-stage operation
5. Male, aged 35	Infected cavity; osteomyelitis of radius	Tarsal cancellous chips; homogenous fresh bones	Penicillin and sulphathiazole used. White donor, Maori recipient. Serous discharge but healed in three weeks
6. Female, aged 2	Congenital dislocation of hip. Shelf operation	Tarsal cancellous block; refrigerated homogenous bone	No chemotherapy used. Early fusion of graft. Some subsequent absorption
7. Male, aged 12 Maori	Tuberculosis of dorsal spine. Bone graft	Cadaveric split ulna, refrigerated; from white man	Penicillin used. Paraplegia: hemilaminectomy and graft; Maori patient
8. Male, aged 33	Osteomyelitis with infective arthritis of hip	Tibial, cadaveric graft from Maori donor, not refrigerated	Extra-articular and intra-articular arthrodesis of hip. Patient white. Operation twenty years ago. Fusion.
9. Male, aged 27	Tuberculous osteitis and cavitation of humeral head	Iliac bone; fresh autogenous cancellous chips	No chemotherapy used. Grafts survived and became incorporated with the host's bone

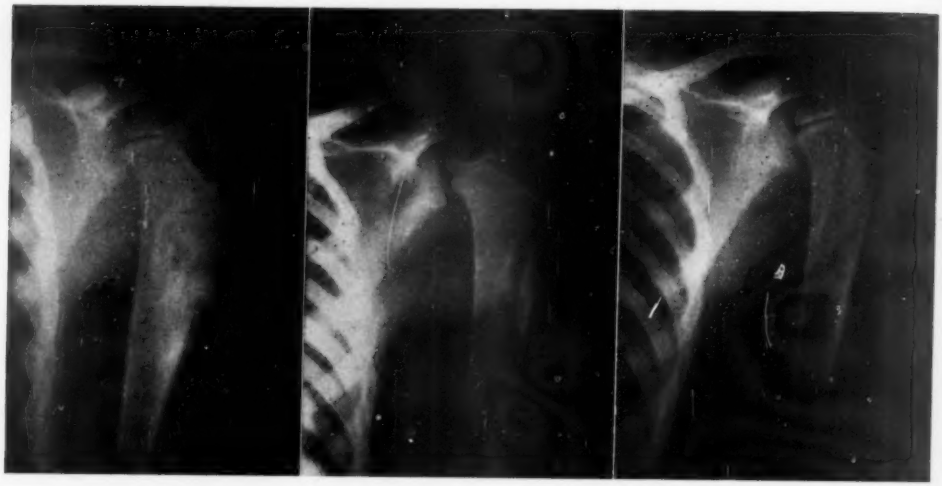


FIG. V.—Case 2: Three weeks after operation.

FIG. VI.—Case 2: Eight weeks after operation. The cortical layer is largely restored and the grafts incorporated with the bone of the host.

FIG. VII.—Case 2: Twelve weeks after operation. The shaft is completely remodelled.

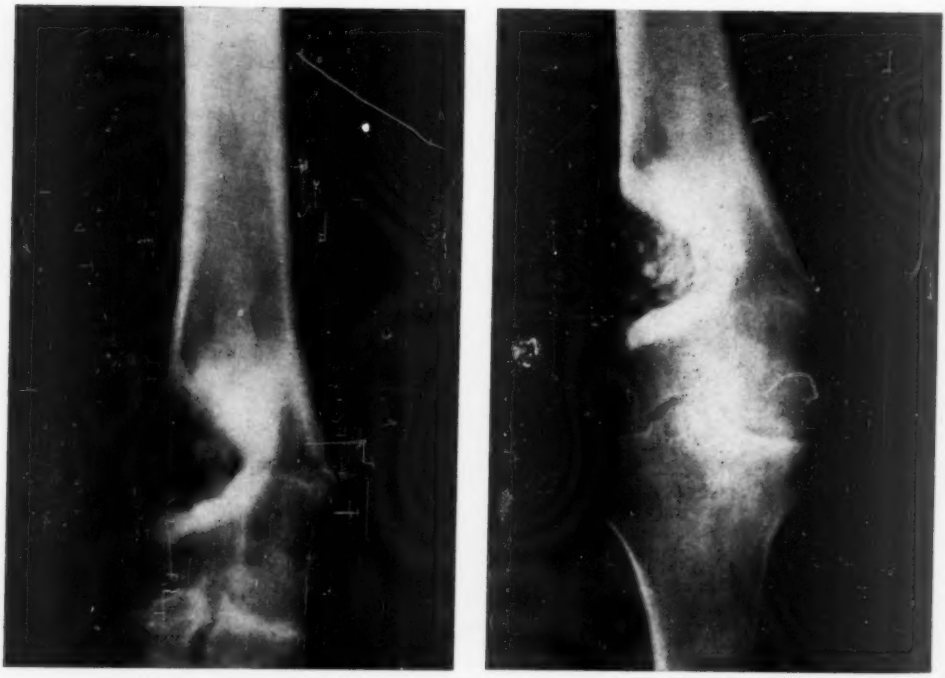


FIG. VIIIa.—Case 3: Cavity and sequestrum in the lateral condyle of femur.

FIG. VIIIb.—Case 3: Eleven weeks after operation. Bone chips filling the cavity.

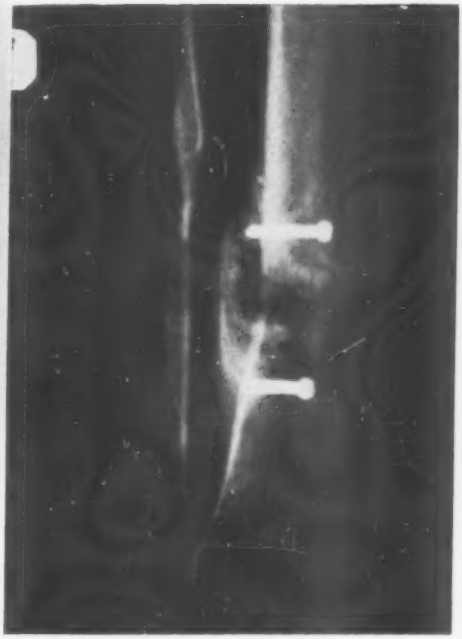


FIG. IX.—Case 4: Twenty weeks after operation. The grafts and chips have become incorporated with the bone of the host. Union from the clinical point of view was better than appeared in the radiograph.

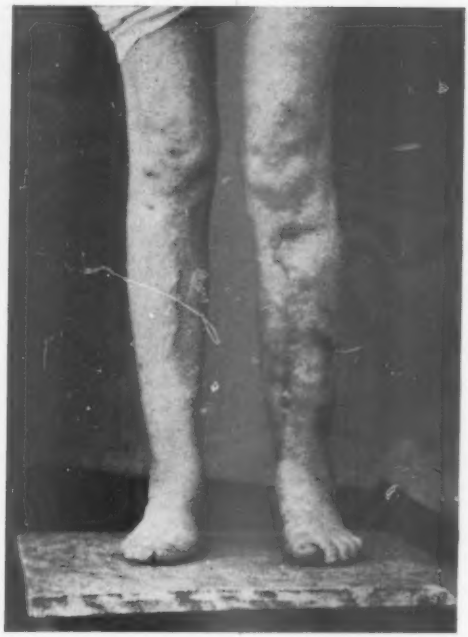


FIG. X.—Case 4: Twenty-two weeks after grafting. Patient walking unassisted.

Both wrists are now strong and painless, with hand-grip indistinguishable from normal. The range of wrist movements is 60% of normal.

A follow-up report six months later indicated that this man is working as a contractor at heavy labour and reports that he has no trouble with either wrist.

This case is typical of several where sterile bone cavities have been filled with cancellous bone chips. Others include fibrocystic disease of the carpal scaphoid tibia and femur. The practice has been well established with surgeons for many years. The case is of interest in itself as a record of traumatic cysts of both carpal scaphoids, one with a fracture (where the bone was excised) and the other grafted. The result in both wrists was a strong and painless grip.

CASE 2.

I.G., female aged 4½, was seen on Sept. 10th, 1948, with a large, hard tumour of the metaphysis of the left humerus. Onset had been gradual with steady increase in size. The tumour was beneath the deltoid and pectoralis major muscles. It did not limit movements of the shoulder (Figs. II - VII inclusive). X-ray examination on Sept. 11th showed a bony tumour of the left upper humeral metaphysis with a smooth, rounded outline. Trabeculae were continuous with the medulla of the humerus. A diagnosis of chondroma or solitary exostosis was made. Radiography of the skeleton did not reveal any further tumours.

Operation, Sept. 17th: The tumour was exposed by reflecting the deltoid outwards. The whole tumour with its cartilaginous cap was removed and the humeral defect filled with cancellous tibial chips from the bone bank (refrigerated homografts). The muscle was sutured over the chips. No chemotherapy was used.

Pathologist's Report. The specimen consists of cancellous bone with cartilaginous cap 3 mm. in thickness. Part of the cortex of the humerus is included. There is active bone formation beneath the cartilaginous cap. The structure is that of a simple exostosis growing from the juxta-epiphyseal part of the humerus.

X-ray examination on Oct. 1st revealed that the bone chips were still clearly visible in the cavity of the humerus (Figs. IV and V). Further X-ray examination showed the incorporation of the bone chips in the humerus and the re-formation of the cortex in eight weeks (Fig. VI), with a final degree of modelling approximating that of a normal humerus (Fig. VII).

The sequence of X-ray films (Figs. II - VII) depicts the stages in the formation of a new cortex and remodelling of the shaft.

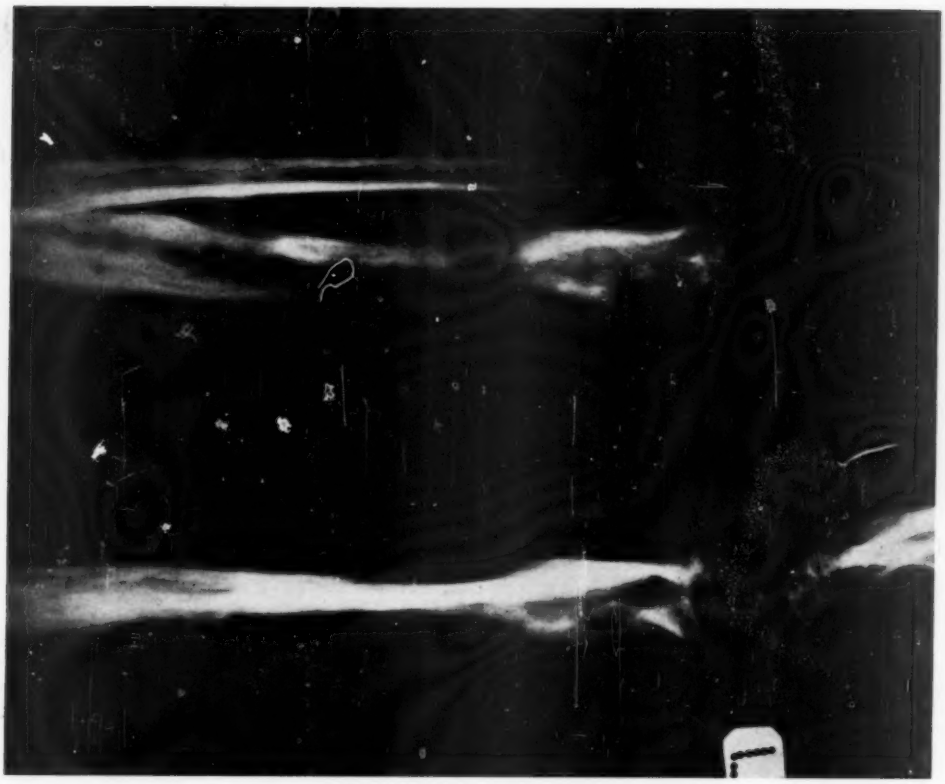


FIG. XI.—Case 5: Showing complete involucrum round the destroyed radius. An infected cavity was present at the lower end with small sequestra.

CASE 3.

L.A., male aged 19, sustained on May 24th, 1947, a compound fracture through the lateral condyle of the femur into the knee joint. Septic arthritis followed, but was controlled by penicillin; however, it later became chronic and intractable. The fracture was T-shaped, supra-condylar and trans-condylar, with a defect of the lateral condyle, infection and sequestra.

Operation, Feb. 15th, 1948: The left knee was arthrodesed; a U-shaped incision was used; the cartilage was removed from the condyles of the femur and tibia and the cavity packed with cancellous bone chips from the ilium (fresh autogenous grafts). The knee was fixed in plaster and firm union resulted. On April 9th the transfer of a tubed pedicle graft from the abdomen *via* the right wrist was completed in order to close the defect in the soft tissues and fill up the bone defect. Penicillin was used locally; the graft healed, but a sinus gradually formed which closed after treatment with penicillin, but recurred at intervals.
X-ray examination showed a rounded bone cavity with some sclerosis of the walls and small sequestra. (Fig. VIIIa).

Operation, July 29th: A cancellous block of bone was removed from the ilium by the trapdoor method and placed in the refrigerated bone bank. The cavity was widely exposed and a pocket of foul-smelling pus evacuated. Haemolytic streptococci and haemolytic staphylococcus aureus both sensitive to penicillin were aspirated from the pus and pseudomonas pyocyanea, which was sensitive to streptomycin but not to penicillin, was also grown.

The cavity was packed and irrigated for one week with eusol and saline and thereafter packed four-hourly with streptomycin in 10 per cent solution.

Operation, Aug. 12th: At this second stage the cavity was curetted thoroughly, sequestra removed and the cavity re-packed with cancellous autogenous chips from the bone bank (refrigerated autogenous graft); the chips were mixed with sulphathiazole-penicillin powder.

Some postoperative serous discharge occurred and the wound is not yet healed (Fig. VIIIb).

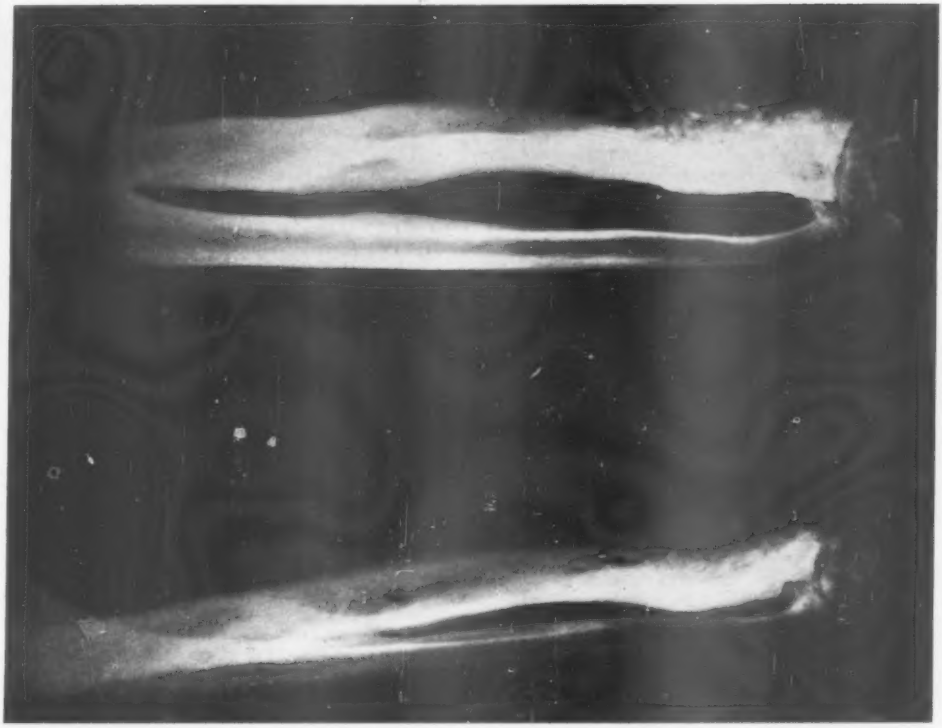


FIG. XII.—Case 5: Three weeks after two-stage chip-bone grafting of the infected cavity.

This patient had two separate grafting operations with cancellous iliac bone in the presence of infection — the first operation being covered by penicillin and the second by penicillin and streptomycin. Chip grafting succeeded where tube-pedicled grafting had failed to eliminate an infected cavity. Although recently completed, this case is included as showing the great value of chip grafting which succeeded after all other methods had failed.

CASE 4.

O.H., female aged 38, was admitted to hospital on Sept. 20th, 1948, having been injured in a collision between a car and a train. She was unconscious and had multiple wounds and fractures. The fractures included closed fractures of four ribs on the left side, closed fracture of the right femur in the sub-trochanteric region with gross displacement, closed fracture of the right femur in the lower third with marked comminution, closed fracture of the upper end of the left fibula, open fracture of the lower third of the left tibia and fibula and a large displaced flap of skin and superficial tissues of the left leg over the lower fractures.

Immediate treatment consisted of *débridement* of the wounds and suturing of the displaced skin and soft tissue flaps, including restoration of the nose and forehead. Parenteral penicillin was given as well as anti-tetanus serum and blood transfusions.

A Thomas splint with a Steinmann pin-traction of the tibia was used for the right femur, and the compound fractures of the left tibia and fibula were immobilized with plaster.

A long period of cerebral irritation followed. Union of the lower right femoral fracture ensued, but mal-union with persisting displacement of the upper right femoral fracture occurred. Non-union of the lower left tibial and fibular fractures occurred with shortening of 2½ inches due to formation of a sequestrum and over-riding of the ends of the bone.

The cultures from the left leg wound were sterile on Sept. 10th.

Restoration of the length of the left tibia was obtained by means of a Hey Groves distracting apparatus. The sequestrum was removed and temporary retention of the bone ends obtained by means of a vitallium plate.

On Dec. 17th the upper fracture in the right femur was exposed and a mass of extraneous callus removed and placed in the bone bank. The bone ends were freshened, apposed and fixed with a moulded vitallium plate. Traction was continued

until union of both femoral fractures was firm. On Jan. 7th, 1949, the vitallium plate was removed from the ununited left tibial fracture and the sclerosed ends of bone resected. Grafting from the bone bank was done (a) with homogenous refrigerated cancellous onlay of iliac bone fixed with four screws and (b) autogenous cancellous

FIG. XIII.—Case 6: Congenital dislocation of the left hip with deficient acetabulum.

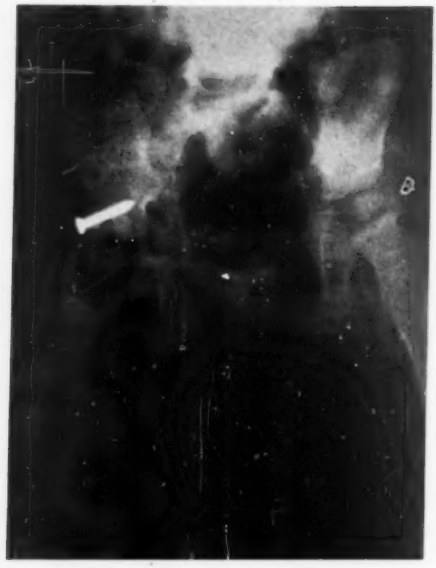


FIG. XIV.—Case 6: Shelf operation with shelf turned down and secured by homogenous wedge graft and vitallium screw.

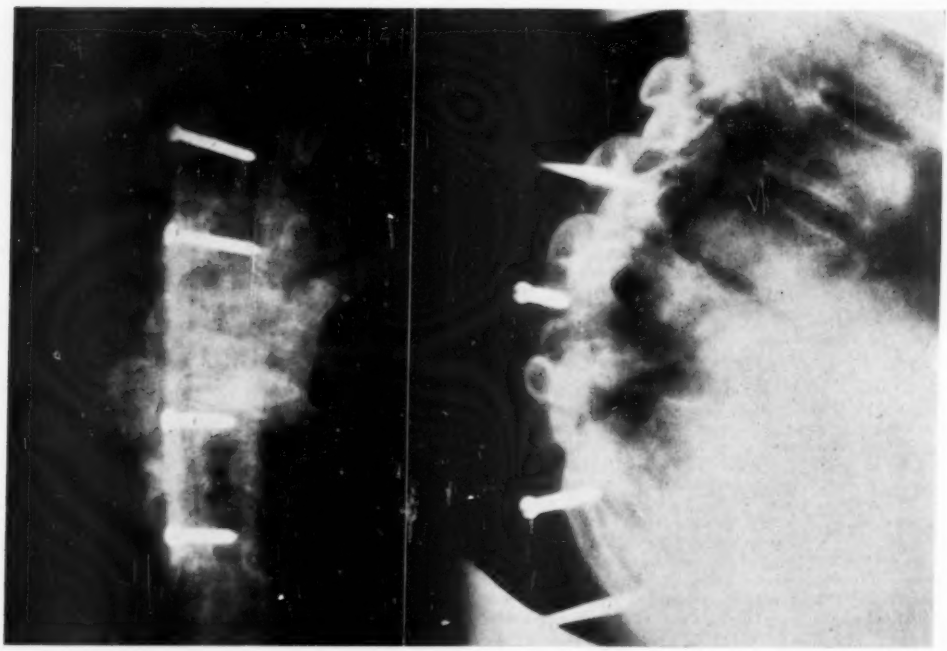


FIG. XV.—Case 7: Tuberculosis of the 10th dorsal vertebra. Homogenous cadaveric graft fixed with vitallium screws.

FIG. XVI.—Case 7: Lateral view of graft. Firm union verified by radiography and biopsy.

refrigerated bone (being the callus removed from the femur) introduced as chips to fill the bone cavity between the ends of the tibia. The wound was completely closed and fixation obtained by plaster. 120,000 units of penicillin were given parenterally for the following five days.

Progressive union of all the fractures occurred in the order of the lower femoral fracture, fibular fracture, upper femoral fracture and tibial (grafted) fracture. On June 3rd, 1949, the two screws were removed from the tibial graft. These had eroded through the scar and caused a mild infection. At this operation the opportunity was taken to examine the homogenous graft which was found to be firmly incorporated with the tibia. X-ray examination on June 14th revealed incorporation of the homogenous onlay and good callus present across the gap between the bone ends. Bone union was considered radiologically to be incomplete, but clinical union was firm and even massive (Fig. IX).

On June 21st the patient was discharged, walking with one stick. All the fractures were united and the wounds healed (Fig. X).

This case illustrates the use of homogenous and autogenous bone grafts in an infected bone cavity. The general condition of the patient for a long period after the accident was one of extreme debility from which a slow and painful recovery was made. The value of cancellous grafts in overcoming non-union and infection was most convincing.

CASE 5.

W.W., male aged 35, a Maori, was admitted to hospital on June 6th, 1947, with a history of recent acute osteomyelitis of the left radius. Gross swelling of the upper part of the radius and of the elbow joint was present. Penicillin in large doses was administered parenterally and on June 6th the upper third of the radius was exposed and drilled. A free discharge of pus containing penicillin-sensitive staphylococci was obtained. On Aug. 20th the whole length of the radius except the articular ends sequestrated; a well-formed involucrum with cloacae was present. On Aug. 22nd the whole shaft of the radius was removed at operation. Penicillin was used locally and drainage established. The patient was re-admitted to hospital on July 5th, 1949, with a persisting sinus at the lower end of the radius. On July 7th the lower end of the radius was exposed, the cavity unroofed, a small sequestrum removed and the cavity packed with penicillin. Pus from the cavity grew a staphylococcus aureus. On July 15th the wound was reopened, all blood clots removed with a curette and the cavity packed with fresh cancellous chips from the tarsus of a white patient. The chips were treated with penicillin-sulphathiazole powder.

Primary healing with the exception of one end of the skin wound followed and complete healing occurred in six weeks (Figs. XI and XII).

CASE 6.

L.M., a female aged 2, suffered from a congenital dislocation of the left hip with a deficient acetabulum (Fig. XIII). The femoral head could not be retained in the acetabulum with plasters and a shelf operation was carried out. Owing to the lack of bone development at such an early age a homogenous refrigerated graft cut from an astragalus and preserved for six weeks in the bone bank was used. In order to fix the graft securely in its new position a vitallium screw was used, the head being countersunk into the graft, the external aspect of which was left clothed with articular cartilage (Fig. XIV).

FIG XVII.—Case 8: Arthrodesis of the right hip twenty years previously in white boy using homogenous Maori cadaveric graft. Firm union present; the graft cannot now be identified from the bone of the host.

X-ray examination six weeks later indicated that the graft was intact and uniting with its surroundings. This patient is still under treatment and is included only as showing one of the many uses of homogenous grafts where the bone of the host is deficient.

CASE 7.

S.W., male aged 12, a Maori, was admitted to hospital on April 7th, 1948, with complete paraplegia below the tenth dorsal level due to collapse

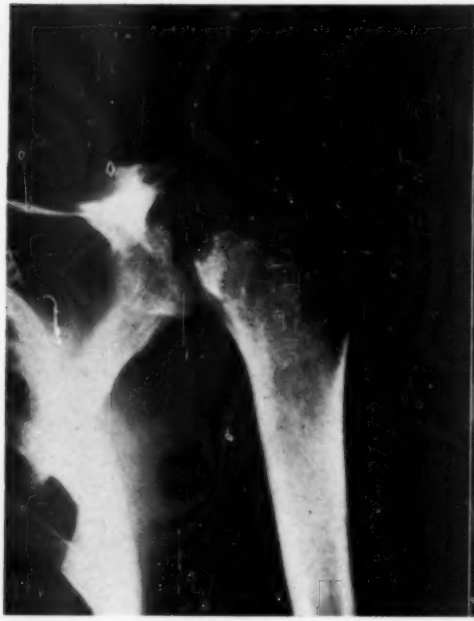


FIG. XVIII.—Case 9: Tuberculous cavitation of the head of the right humerus, before operation.

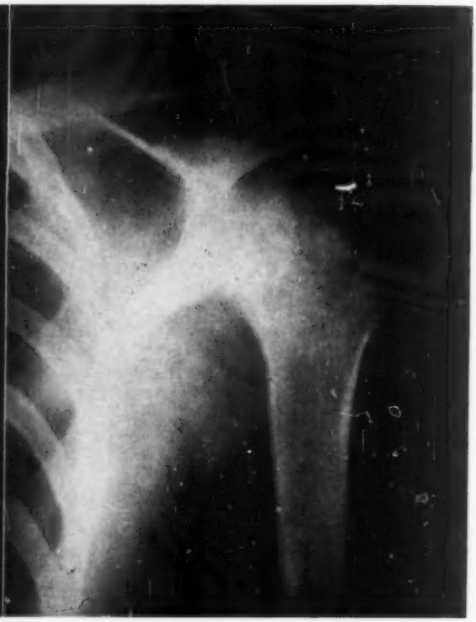


FIG. XIX.—Case 9: Twenty-one months after operation by autogenous chip grafting. The grafts have survived and fused with the bone of the host, largely restoring the defect in the bone, but the ankylosis is unsound.

of a tuberculous tenth dorsal vertebra. Spinal puncture and Queckenstedt test on May 7th showed a pressure of 50-60 mm. with respiratory fluctuation, but no rise in pressure on jugular compression. A pink-coloured fluid was obtained at a slow rate of drip, ceasing at 2 c.c.

The pathologists report on this fluid revealed 8 cells per c.mm., 450 mgm. protein per 100 c.c. and globulin greatly increased; there was no reduction in the chlorides. Cultures were sterile and no tubercule bacilli could be demonstrated on staining nor grown after nine weeks of incubation on egg media.

The patient was nursed in a special rotating spinal bed with traction against the body weight to reduce the kyphus, but after seven months no spontaneous recovery had occurred.

On Dec. 10th, 1948, hemi-laminectomy of the 9th, 10th and 11th dorsal vertebrae was performed. A cadaveric homogenous refrigerated graft five inches long from the amputated forearm of a white patient was fixed to the dorsal spines with vitallium screws. Cancellous bone from the same cadaveric specimen was laid alongside the graft. The graft included the spines of the 8th - 12th dorsal vertebrae inclusive and was fixed with four screws. After dusting with sulphathiazole, the wound was closed.

X-ray examinations in February and April, 1949, showed progressive union of the graft (Figs. XV and XVI). Control of the bladder and rectum returned, but no power in the lower limbs.

On April 16th, 1949, the graft was explored with a view to trimming the ends which projected somewhat beneath the tissues of the back owing to the kyphus. The graft was exposed in its whole length and found to be covered with a membrane which could be peeled from it like periosteum. It was firmly incorporated with the spinous processes and could not be separated with a fine osteotome. The ends of the graft removed during remodelling provided some bone chips for pathological examination and the report on these showed that they consisted of dead or sequestrated bone in the process of replacement by new bone formation.

CASE 8.

L.M., male aged 33, had suffered from osteomyelitis of the femur and acute arthritis of the right hip at the age of 13. After this infection had subsided, an extra- and intra-articular arthrodesis of the hip was carried out, using a fresh homograft from the amputated leg of a young Maori. Now after twenty years the graft cannot be seen, but there is sound bony fusion of the hip in a good position (Fig. XVII).

This early case, together with numbers 5 and 7, appears to show that cross grafting of viable bone between Maori and white man can be successfully carried out.

CASE 9.

G.C., male aged 27, has suffered from gradual loss of abduction and external rotation at the right shoulder with occasional pain. X-ray examination showed a "multiloccular cavity" in the head of the humerus encroaching on the articular surface.

On Dec. 15th, 1947, the deltoid was reflected and the humeral head exposed. Erosion of the bone was present, with a large irregular multiloccular cavity and a considerable loss of the outer articular surface of humeral head. The thickened synovial membrane was excised, the bone cavity curetted and packed with fresh iliac bone chips.

The pathologist's report on the specimens of bone and synovial membrane showed that the condition was tuberculous osteitis and synovitis.

After a short period of clinical improvement the stiffness increased and a fibrous ankylosis occurred in the adducted position; it is obvious that arthrodesis will be required. This has since been successfully carried out, aided by a course of streptomycin.

The interest of this case, however, lies in the fact that the cancellous grafts in a tuberculous cavity survived and became incorporated with the bone of the host without sequestration (Figs. XVIII and XIX).

SUMMARY.

1. The place of homogenous grafts of bone and cartilage has been briefly described, in the light of modern progress.

2. A small number of cases is presented illustrative of their uses.

3. Selections have been made from the extensive bibliography.

ACKNOWLEDGEMENTS.

I wish to express my grateful thanks to the Secretary of the Royal Australasian College of Surgeons and to the Librarian of the Gordon Craig Library for the loan of journals and reprints dealing with various aspects of the subject.

REFERENCE.

ABBOTT, Le. R. C., BOST, F. C., SCHOTTSTAEDT, E. R., STERN, W. E., and MCCORKLE, H. J. (1946), *Surg. Gynec. Obstet.*, vol. 83, page 101.

ALBEE, F. H. (1940), "Bone graft surgery in Disease, Injury and Deformity.' New York: D. Appleton-Century Co.

ALDRIDGE, R. H. (1948), *J. Bone Jt. Surg.*, vol. 30A, page 70.

AXHAUSEN, G. (1908), *Arch. klin. Chir.*, vol. 88, page 23.

BANKART, Blundell A. S. (1945), *Proc. Roy. Soc. Med.*, vol. 38, page 618.

BARSKY, A. J. (1945), *Surgery*, vol. 18, page 755.

BAXTER, H., and ENTIN, M. A. (1948), *Plast. Reconstruct. Surg.*, vol. 3, page 303.

BENESH, R., CHANCE, M. R. A., and GLYNN, L. E. (1945), *Nature*, vol. 155, page 203.

BISGARD, T. D. (1934), *Surg. Gynec. Obstet.*, vol. 58, page 817.

BLAKEMORE, A. H. (1946), *Surg. Clin. N. Amer.*, vol. 26, page 326.

—— and LORD, J. W. (1945), *Ann. Surg.*, vol. 121, page 435.

—— —— and STEFKO, P. L. (1942), *Surgery*, vol. 121, page 488.

—— —— —— (1943), *Ann. Surg.*, vol. 117, page 481.

BRACKETT, E. G. (1938), *J. Bone Jt. Surg.*, vol. 20, page 93.

BROOKS, Barney, and HUDSON, W. A. (1920), *Arch. Surg.*, vol. 1, page 284.

BROWN, J. B. (1940), *Surg. Gynec. Obstet.*, vol. 70, page 1079.

—— and DE MERE, McC. (1948), *Plast. Reconstruct. Surg.*, vol. 3, page 283.

BUNNELL, Sterling (1948), "Surgery of the Hand." J. B. Lippincott Co., Philadelphia, 2nd Edition, page 304.

BUSH, L. F. (1947), *J. Bone Jt. Surg.*, vol. 45, page 620.

CAMPBELL, W. C. (1949), "Operative Orthopaedics." C. V. Mosby Co., St. Louis, 2nd Edition, page 122.

CARREL, Alexis (1912), *J. Amer. Med. Assoc.*, vol. 59, page 523.

COLEMAN, H. M., BATEMAN, J. E., DALE, G. M., and STARR, D. E. (1946), *Surg. Gynec. Obstet.*, vol. 83, page 392.

DICKSON, F. D. (1944), *Amer. Acad. Orthop. Surg.*, page 11.

DUPERTUIS, S. M. (1941), *Arch. Surg.*, vol. 43, page 32.

FIRESTONE, C. (1946), *Amer. J. Surg.*, vol. 72, page 153.

GHORMLEY, R. K., and STUCK, W. G. (1934), *Arch. Surg.*, vol. 28, page 742.

GILLIES, Sir H. (1943), *Brit. J. Surg.*, vol. 30, page 305.

GORDON, S. D., and WARREN, R. F. (1947), *Ann. Surg.*, vol. 125, page 237.

GROVES, E. W. Hey (1939), *Lancet*, vol. 1, page 69.

HENRY, M. O. (1948), *J. Bone Jt. Surg.*, vol. 30A, page 70.

INCLAN, A. (1942), *J. Bone Jt. Surg.*, vol. 24, page 81.

KEITH, W. S. (1934), *J. Bone Jt. Surg.*, vol. 16, page 314.

KEY, J. A. (1934), *J. Bone Jt. Surg.*, vol. 16, page 176.

—— (1940), *J. Bone Jt. Surg.*, vol. 31A, page 150.

KIRKHAM, H. L. D. (1940), *Ann. Surg.*, vol. 3, page 896.

LEXER, E. (1925), *Surg. Gynec. Obstet.*, vol. 60, page 782.

—— (1935), *Zbl. Chir.*, vol. 62, page 1987.

LOEB, Leo (1926), *Amer. J. Path.*, vol. 2, page 111.
—— (1926), *Amer. J. Path.*, vol. 2, page 315.
—— (1927), *Amer. J. Path.*, vol. 3, page 29.
—— (1927), *Amer. J. Path.*, vol. 3, page 45.
—— and SIEBERT, W. J. (1935), *Arch. Path.*, vol. 20, page 28.
McGAW, W. H., and HARBIN, M. (1934), *J. Bone Jt. Surg.*, vol. 16, page 816.
MASON BROWN, J. J. (1948), *Brit. J. Surg.*, War Surgery Supplement, No. 2, page 354.
MATTHEWS, D. N. (1945), *Lancet*, vol. 1, page 775.
MEYER, A. W. (1931), *Dtsch. Z. Chir.*, vol. 232, page 473.
MEYERDING, H. W. (1945), *J. Bone Jt. Surg.*, vol. 27, page 196.
MOORE, John Royal (1948), *J. Bone Jt. Surg.*, vol. 30A, page 313.
MORGAN, C., JAMESON, W. A., and POWELL, H. M. (1933), *Amer. J. Immunol.*, vol. 25, page 121.
MOWLEM, A. R. (1944), *Lancet*, vol. 2, page 746.
—— (1945), *Proc. Roy. Soc. Med.*, vol. 38, page 171.
MURRAY, G. D. W. (1940), *Brit. J. Surg.*, vol. 27, page 567.
MURRAY, G. R. (1944), *Amer. Acad. Orthop. Surg.*, page 532.
O'CONNOR, G. B., and PIERCE, G. W. (1938), *Surg. Gynec. Obstet.*, vol. 67, page 796.
O'CONNOR, G. B. (1939), *Amer. J. Surg.* vol. 45, page 563.
ORELL, S. (1937), *J. Bone Jt. Surg.*, vol. 19, page 873.
PEER, L. (1939), *Surg. Gynec. Obstet.*, vol. 68, page 603.
—— (1941), *Arch. Otolaryng.*, vol. 34, page 696.
—— (1944), *Surg. Clin. N. Amer.*, New York Number, page 404.
—— (1946), *Plast. Reconstruct. Surg.*, vol. 1, page 108.
PENN, J., JANKOWITZ, J., and BREWER, A. (1948), *Plast. Reconstruct. Surg.*, vol. 3, page 228.
PHEMISTER, D. B. (1930), *J. Bone Jt. Surg.*, vol. 12, page 769.
PIERCE, G. W. (1930), *Surg. Gynec. Obstet.*, vol. 50, page 601.
POWELL, H. M., JAMESON, W. A., and JONES, F. G. (1933), *J. Immunol.*, vol. 24, page 185.
SEDDON, H. J. (1948), *Brit. J. Surg.*, War Surgery Supplement, No. 2, page 325.
SERJEANT, T. R. (1946), *J. Canadian Med. Assoc.*, vol. 54, page 119.
STRUMINA, M. M., and HODGE, C. C. (1945), *Amer. J. Surg.*, vol. 121, page 860.
TURNER, T. B. (1938), *J. Exper. Med.*, vol. 67, page 61.
URIST, M. R. (1942), *J. Bone Jt. Surg.*, vol. 24, page 47.
WADE, Henry (1920), *Edin. Med. J.*, vol. 24, page 37.
WAGNER, L. L. (1929), *Amer. J. Surg.*, vol. 6, page 801.
WEBSTER, T. P. (1944), *Amer. J. Surg.*, vol. 120, page 431.
WILSON, P. D. (1947), *Ann. Surg.*, vol. 126, page 932.
YOUNG, Forrest (1945), *Surgery*, St. Louis, vol. 17, page 616.

CARCINOMA OF THE UTERUS.

THE METHODS AND RESULTS OF TREATMENT AT THE ALFRED HOSPITAL CLINIC, 1928 - 1943.

By J. M. BUCHANAN.

Melbourne.

THE METHODS OF TREATMENT.

IT is interesting, at times, to recall the beginnings of a project and follow the development of an established unit through its difficult initial stages. With the issue to selected Hospitals by the Commonwealth of Australia of an adequate supply of radium in 1928, the cancer clinic in the Gynaecological Unit of the Alfred Hospital came into being.

The treatment of uterine carcinoma at that time was beset with considerable difficulty and disappointment and the advent of a new weapon to the armamentarium was therefore welcomed with open arms. However, it was a comparatively new procedure with technical methods all its own and knowledge had to be gained in the hard school of experience. The radio-therapeutic centres in the Old World had nominated certain technical methods of employing radium to utilize its physical properties to the best advantage and to ensure as even a radiation to the affected area as possible. The question of appropriate dosage was practically settled and it remained for the staff of the clinic to evaluate these methods and try to cure or comfort the numerous sufferers. The results for the 15-year period (1928 - 1943) are set out in this paper.

CARCINOMA OF THE CERVIX.

Assessment of cases.

It was early realised that accurate clinical appreciation of the stage of the disease was essential, both from the point of view of rational therapy and of prognosis. The clinical findings in each patient were recorded in detail on entry, and these findings verified, and amplified, if necessary, by careful examination under anaesthesia prior to treatment. The League of Nations Classification (1937) was adopted as soon as it was made available. The appreciation of the clinical stage has always been regarded as most important.

Classification.

Stage (i):

The carcinoma is strictly confined to the cervix.

Stage (ii):

The carcinoma infiltrates the parametrium on one or both sides to a maximum of half an inch from the cervix. There is still a limited uterine mobility. There may be some spread on to the vaginal fornices.

Stage (iii):

The carcinoma infiltrates the parametrium beyond the line of the ureters and may extend to the lateral pelvic wall on one or both sides. Advanced cases of this stage present the classical "frozen" pelvis. In other types there may be a diffuse submucous infiltration involving the vesico-vaginal and recto-vaginal septa. In this stage, uterine mobility is negligible.

Stage (iv):

(a) The presence of malignant vesico-vaginal fistula.

(b) The presence of malignant recto-vaginal fistula.

(c) Remote metastases, e.g., spine, skull, mediastinum, etc.

The determination of the stage of disease requires a certain amount of experience, and it is likely that the assessment of experienced observers may vary. We find it difficult to imagine that cases in stage (iv) when first seen will live for five years, and, in point of fact, very few in this series have survived more than six months. Figures have been published from reputable clinics giving 5 - 6

per cent five-year survival rate in stage (iv). It would appear that their opinion as to what constitutes stage (iv) varies greatly from our own.

It is of fundamental importance to recognise clearly that the clinical type of lesion has no relation whatsoever to its stage. Thus some of the fungating tumours are quite frightening when first encountered because of the intense cellular overgrowth and superficial necrosis that can be observed, yet, in view of parametric spread and fixation, are in early stage (ii). Likewise some insignificant cervical ulcers may have already made such grave inroads along the pelvic cellular tissues as to render the ultimate prognosis very serious.

In the original clinical appreciation of the stage of the disease, it is found at times that there is a tendency to grade the condition into a more severe stage. This is particularly so when there is a good deal of superadded infection in the primary tumour. Much of the apparent parametric infiltration in such cases is inflammatory in nature and resolves comparatively quickly after successful irradiation. This may be one explanation of the reasonably good results in stage (iii) cases.

Biopsy.

At the time of the original treatment, opportunity is taken to obtain an adequate biopsy specimen for microscopic proof of the presence of carcinoma. This is secured either by the diathermic cutting loop or by excision with the scalpel.

TABLE 1.

	BIOPSY		
	Performed in	Not performed in	Total
Early cases	69	6	75
Late cases	105	37	142
TOTAL	174	43	217

The errors of omission seen in this table are explainable by the human error such as mislaying the specimen in transit to the laboratory or occasional loss of the transcription record. No early case has been included that was not clinically "classical". Of the advanced cases, we have contented ourselves with clinical diagnoses in many of those for whom only palliative treatment was ordered.

No special effort at classification by cellular structure has been attempted beyond differentiation into epidermoid and adenocarcinomatous types. R. A. Willis, who was associated with our histological diagnoses for many years, had no confidence in the well-known Broders' classification, but used such terms as "anaplastic", "well differentiated", etc.

Radiotherapeutic measures.

In the early years some therapeutic attempts were made with local interstitial needling with radium, but in a very short time the Paris technique for radium therapy was adopted, and this method has been our standard practice for many years.

The radium available to this clinic is screened with one millimetre of platinum, and it has been found necessary to limit the therapeutic dose with this screenage to 5,500 milligramme-hours. Any attempt to increase this dose will meet with disaster in the nature of intractable burns and fistulae.

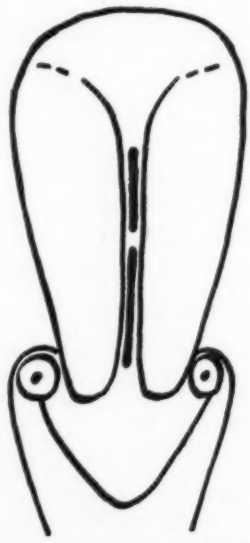


FIG. I. Diagrammatic representation of the standard radiation technique for cases of carcinoma of the cervix.

Increased radium dosage can only be obtained when more adequate screenage is available.

The routine adopted is to use 30 milligrammes of radium in an intrauterine tube in tandem, with a 10-milligramme tube above and a 20-milligramme tube below. In addition, a 10-milligramme tube is carried in each of two corks, mounted on a colpostat which is introduced so that each cork fits snugly into the corresponding lateral fornix (Fig. I). The vagina is tightly packed with acriflavine emulsion gauze to prevent movement of the applicators as far as possible. The tubes are left in situ for 100 hours as a rule. Occasionally the radiation flares up an old pelvic inflammation, or marked absorption may occur from the tumour site which is often heavily infected. We have found it essential to direct that the radium be removed, irrespective of dosage obtained, should the temperature remain over 101°F. for more than 12 hours. In such cases a second irradiation after four to five weeks is usually quite satisfactory.

As modifications of this standard procedure, implantation of gold radon seeds directly into the parametria by means of a blunt cannula or direct needling of the tumour have been practised on odd occasions. This latter method is particularly applicable to cases of "stump" carcinoma which form quite an appreciable number in this series (6 per cent). As the potential risk did not seem commensurate with the possible gain, blind implantation of radon seeds has been abandoned for many years past.

Originally, the majority of cases treated with radium were followed by a course of deep X-ray therapy. Recently, not so much emphasis has been laid on this procedure. There is no doubt that in many cases it produces a prolonged and severe constitutional disturbance, particularly when administered over the lower abdomen. It would appear that cases adequately treated by radium do not require X-ray therapy, while those whose radium treatment is inadequate do not benefit by it.

As stated above, histological classification has not been attempted. The recent researches of Glucksmann and Spear on the sensitivity of the cells to primary radiation, which allows for a fairly accurate prognosis within a short period after the treatment, requires histological diagnosis of the very highest order. We depend upon a persistent and adequate examination at monthly intervals after the treatment to decide whether further therapy or operation is likely to be required.

The mere fact that the original tumour shrinks and often disappears is of little significance. The main scrutiny should be directed towards the parametric areas for evidence of progressive softening in favourable cases, or increased thickening when the outlook is not so satisfactory. It is, of course, essential not to omit the rectal examination in these cases.

Meticulous follow-up records are maintained until their fifth anniversary of treatment, after which the patient is requested to make a yearly visit or notify the clinic of her condition by letter.

Late recurrences are uncommon, but do occur. One patient who was successfully treated for carcinoma of the cervix with radium in July, 1930, remained in good health for eight years, and then left the State. In August, 1948, she was successfully operated on in Sydney for carcinoma of the body of the uterus, panhysterectomy being performed. As the cervix was reported as "healthy", this was apparently a primary lesion. This must be a most unusual development after apparently successful radiation.

Operative measures.

Excision of the tumour and the gland-bearing area intact is a highly satisfactory principle to adopt in any malignant growth. Although this involves a very extensive dissection in numerous pelvic tissue planes when applied to carcinoma of the cervix, we are convinced that radical surgery holds an established place in the treatment of this disease.

In the earlier cases results were rather disappointing, largely owing to the pelvic sepsis which not infrequently followed. In the absence of drugs of the sulphonamide series, and with the limited supplies of blood available for transfusion resuscitation, there was an appreciable mortality, and for a period radiotherapeutic measures were used exclusively.

However, in 1932 tentative steps were taken to restore the operation of extended excision to our clinical therapeutics, and quite a few patients had been operated on up to 1940 without operative mortality. These were essentially "good" cases in stages (i) and (ii), and the survival rate is relatively high. Except for a period of years during the Pacific war, this policy has been maintained

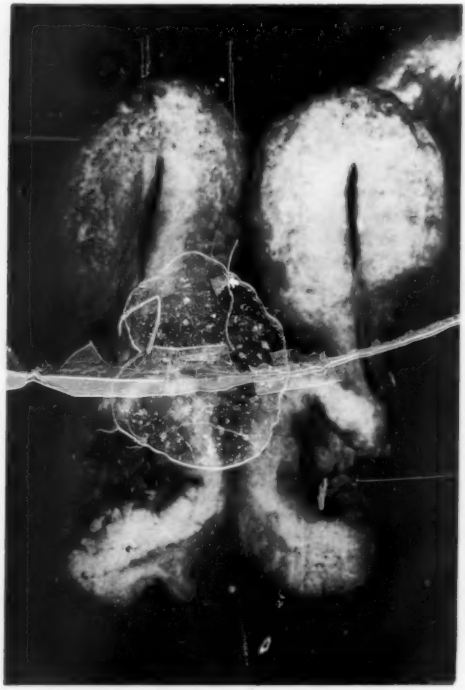


FIG. II. Specimen removed by primary operation, showing the type of case in which, in our opinion, dilatation of the cervix for introduction of radium would be a risky procedure.

with considerable satisfaction. The majority are given preoperative radium application followed by operative removal.

As all who have had much contact with carcinoma of the cervix are aware, there is a type of case in which dilatation of the cervical canal (if it can be found with any degree of certainty) is extremely difficult and raises grave doubts as to whether the uterine wall will not be perforated at any moment. Especially is this so if pyometra is present. Most of these are primary endocervical tumours, and we are inclining to the view that if these are still in stage (ii), there is a good deal to be said for primary operation without incurring the risks of preliminary radiation.

The extended excision for carcinoma of the cervix is not an operation to be undertaken lightly, calling for more than a casual acquaintance with pelvic anatomy. In his training for this procedure we feel that the operator should have taken the opportunity to observe the technical details as performed by a competent surgeon, not once, but many

FIG. III. Another specimen of the same type as shown in Fig. II.

times. We also consider that prior to undertaking this operation he should be fully conversant with the simpler operation of total hysterectomy for non-malignant conditions. We aim to complete the operation within ninety minutes, and, with adequate blood available and a protective sulphadiazine cover, do not anticipate complications in the convalescence.

If the combined procedure of primary radiation followed by operation is to be undertaken, it is desirable to ensure that there is a space of not more than two months between the two treatments. The ideal time is about six weeks. If, for any reason,

operation is delayed for more than three months, a good deal of scarring may be found, making dissection of the pelvic cellular tissues both tedious and difficult. Two such cases were followed by an intractable ureteric fistula which failed to heal spontaneously after twelve weeks and required nephrectomy.

CARCINOMA OF THE BODY.

Abdominal panhysterectomy has remained our sheet-anchor for this condition throughout the years. Sometimes preoperative cavitational radium is very useful to consolidate a friable tumour, and certainly renders the manipulation of the uterus during panhysterectomy less hazardous.

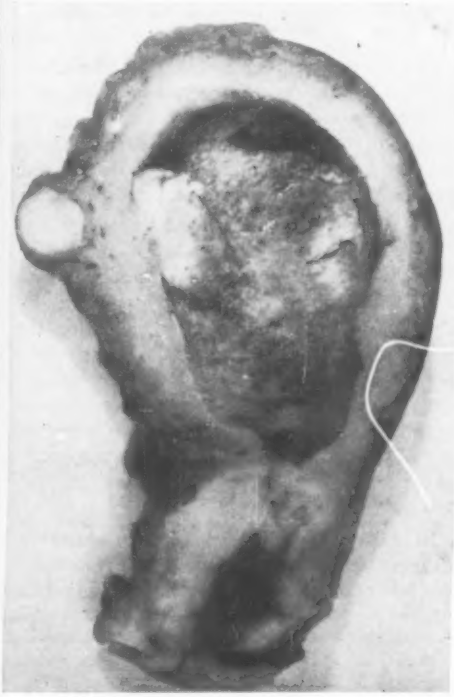


FIG. IV. Specimen showing primary endocervical carcinoma with stenosis of the canal and pyometra.

The immediate operative results have been satisfactory despite the advanced age at which some patients present for treatment. However, the five-year survival rate, perhaps because of that same age factor, has been rather disappointing.

Radium therapy by intrauterine application was practised in some of our earlier cases without the success attending cases of carcinoma of the cervix. Where the medical condition is such as to preclude major operation (we recognise especially diabetes, cardiac insufficiency and gross obesity), radium has been administered by intrauterine applicators usually at two sittings of 3,000 milligramme-hours dosage on each occasion.

Massive radium dosages (up to 12,500 milligramme-hours) have been reported from American clinics with residual carcinoma still demonstrable in the excised uterus. It would appear that it is in the interests of the patient to rely on an efficient panhysterectomy as the method of choice rather than trust to a somewhat problematical eradication by radium alone.

Because this disease tends to be largely confined to the uterus for a long time, we feel that no case should be labelled inoperable merely because of the duration of the symptoms. It is not inoperable until laparotomy has been performed by a competent operator and the condition found to be irremovable. One such case, with symptoms of irregular bleeding for three and a half years, had been called inoperable for two of those years and treated without marked relief by deep X-ray therapy. However, it was possible to perform an adequate panhysterectomy with complete relief.

RESULTS.

It is desired to present the survival rates of all patients who have applied for treatment in the 15-year period (1928 - 1943) in as simple a form as possible. Most cases were proven by biopsy. By arbitrarily concluding this series as at the end of 1943, it is possible to present five-year "cure" rates.

TABLE 2.

(All cases 1928-1943.)

CARCINOMA OF THE CERVIX.

Stage.	Total number seen.	Total number treated.	Survivors.
(i)	17	17	8
(ii)	58	58	36
(iii)	105	102	17
(iv)	37	15	—
	217	192	61
Survival rate of all cases			28.1 per cent
Survival rate of treated cases ..			31.7 per cent

TABLE 3.

(Analysis by stages.)

CARCINOMA OF THE CERVIX.

Period in years	No. alive at beginning of period	No. dying during period.	No. not traced during period.	No. alive at end of period.
STAGE (i):				
0–1 . . .	17	1	—	16
1–2 . . .	16	—	—	16
2–3 . . .	16	1	1	14
3–4 . . .	14	—	—	14
4–5 . . .	14	2	4	8
STAGE (ii):				
0–1 . . .	58	2	—	56
1–2 . . .	56	4	1	51
2–3 . . .	51	4	—	47
3–4 . . .	47	4	1	42
4–5 . . .	42	2	4	36
STAGE (iii):				
0–1 . . .	105	35	1	69
1–2 . . .	69	28	—	41
2–3 . . .	41	13	1	27
3–4 . . .	27	8	—	19
4–5 . . .	19	1	1	17
STAGE (iv):				
0–1 . . .	37	31	—	6
1–2 . . .	6	6	—	—
2–3 . . .	—	—	—	—
3–4 . . .	—	—	—	—
4–5 . . .	—	—	—	—

Carcinoma of the cervix.

It will be seen that 217 patients were attended during the period under review. Of these, 61 reached the haven of the five-year cure (28.1 per cent). Fourteen cases were untraced, although 9 of these had reached their fourth anniversary. Twenty-five cases were recorded as being so far advanced that palliative measures only could be undertaken. Thus, of the patients accepted as suitable for treatment, 61 out of 192 were still alive after five years (31.7 per cent).

Radical operation was performed for 28 patients, with 3 operative deaths which occurred early in the series. Seventeen were cured for five years or more, and 4 died from other causes without any evidence of recurrence. Two were untraced.

An interesting point arises here on the frequency of the "stump" carcinoma following subtotal hysterectomy. In this series of 217 cases we encountered no fewer than 13 cases in which subtotal hysterectomy had been performed, in many cases years before.

TABLE 4.

CASES OF "STUMP" CARCINOMA.

Case No.	Time in years elapsed since subtotal hysterectomy.	Survival period in years.
1	10	1
2	5	1
3	*2	2
4	5	16
5	21	1 (Died other causes)
6	*2	2
7	*½	½
8	*1	1
9	20	4
10	16	1½
11	20	6
12	20	½
13	30	1½

These 13 cases constitute 6 per cent of the whole series.

*Probable carcinoma present at the time of the original operation.

The treatment was not very satisfactory and the results are not encouraging, only 2 surviving more than five years. It would appear that at least four of these patients had carcinoma of the cervix present at the time of the original subtotal hysterectomy.

Carcinoma of the body.

During the same period 77 patients with proven carcinoma of the body came under review. Allowance should be made for the fact that the average age of these patients was 60 years. Of these, 9 were so far advanced that palliative measures only could be undertaken. Twenty-six patients survived to the fifth anniversary of their treatment.

CONCLUSION.

In spite of publicity campaigns and increasing lay knowledge of early symptoms, far too many sufferers present in advanced stages of the disease, so much so that it is sometimes said that the treatment of uterine cancer is depressing and disappointing. Perhaps it is.

However, the principles and practice of radium therapy, the art and technique of efficient panhysterectomy, with their multiple combinations, are not learned in a day, but call for much earnest application over the years. The student must be prepared to study the technical manipulations of radium implantation, and to acquire the manual

dexterity for the smooth performance of the necessarily wide pelvic ablations. Thoroughly equipped, he may approach his task with equanimity.

Many will perish despite all care, but the gratitude of the survivors is heart-warming and their restoration to vigorous health a pleasure to all concerned.

TABLE 5.

CASES IN WHICH RADICAL HYSTERECTOMY WAS PERFORMED.

Period in years.	No. alive at beginning of period.	No. dying during period.	No. not traced.	No. alive at end of period.	Remarks on mortality.
STAGE (i):					
0–1	7	1	—	6	One operative death.
1–2	6	—	—	6	
2–3	6	—	—	6	
3–4	6	—	—	6	
4–5	6	—	1	5	One extended vaginal hysterectomy.
STAGE (ii):					
0–1	21	2	—	19	Two operative deaths.
1–2	19	—	—	19	
2–3	19	2	—	17	One — acute febrile illness One — other causes.
3–4	17	2	1	14	One — recurrence One — other causes.
4–5	14	1	1	12	One died of carcinoma of stomach.

TABLE 6.

CARCINOMA OF THE BODY. (All cases.)

Number attending for treatment: 77. Number accepted for treatment: 68 (4 by radiation only; 64 by operation only.) Survivors: 26.

Period in years.	No. alive at beginning of period.	No. dying during period.	No. not traced during period.	No. alive at end of period.	Remarks.
0–1	77	25	1	51	Six operative deaths.
1–2	51	5	—	46	
2–3	46	8	2	36	
3–4	36	3	1	32	
4–5	32	4	2	26	

Survival rate of all cases .. .. 34 per cent.
Survival rate of treated cases .. .. .. 38 per cent.

CASE REPORTS.

AN ATYPICAL LYMPHADENOID GOITRE ENCIRCLING THE TRACHEA AND LARYNX.

By J. P. FLEMING.

(From the Division of Surgery, Radcliffe Infirmary, Oxford.)

THIS case is recorded because of its clinical and pathological interest.

The goitre was very large and X-ray examination showed extreme forward displacement of the trachea. At operation the gland completely encircled the trachea and larynx, and histological examination showed features of both lymphadenoid goitre and Reidel's struma. The presence of both these appearances in the one gland is consistent with the view that Reidel's struma is a late development of Hashimoto's thyroiditis, and it is possible that the gland may have been removed during the stage of transition.

Complete encirclement of the trachea and larynx is rare and the degree of forward displacement of the larynx and trachea, as seen in this case, is uncommon.

A similar case to the one here described was recorded by Oldfield (1948).

CASE REPORT.

Mrs. E.W., aged 50, machinist, noticed a "swelling in her throat" four years prior to admission to the Radcliffe Infirmary on Nov. 10th, 1948.

The swelling became more prominent when she grew tired and it was frequently the site of a dull, aching discomfort. She noticed that the goitre decreased in size after resting, particularly when she was on holiday.

Three to four months prior to admission to hospital she had noticed difficulty in swallowing and felt that "something was pressing on her throat".

On examination the patient was quite placid, the pulse rate was 72 per minute and the temperature was normal. She had a firm, smooth enlargement of the thyroid gland involving both lobes and the isthmus and causing backward displacement of the carotid vessels. There were no signs of thyrotoxicosis and there was no evidence of venous obstruction at the thoracic inlet (Fig. I). No bruit was heard over the gland. A plain radiograph of the neck showed marked forward displacement of the trachea (Fig. II). Laryngoscopy showed no evidence of recurrent laryngeal palsy.

Operation.

On Nov. 12th, under Pentothal 0.5 g. ethyl chloride and ether, followed by infiltration with amethocaine 150 cc. of a 1/1,000 solution, and adrenaline 1/400,000, subtotal thyroidectomy was performed.

The gland was pale and firm with numerous blood vessels on its surface. Posteriorly, the lateral lobes extended behind the trachea and lower portion of the larynx, completely encircling these structures. The isthmus was firmly fixed to the trachea and thyroid cartilage.

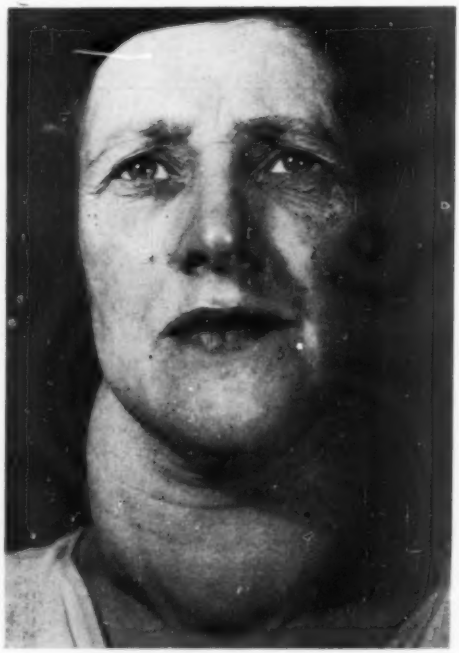


FIG. I. Photograph showing clinical appearance.

Convalescence was uneventful and the patient was discharged 10 days later.

The plain radiograph of the neck after operation showed the trachea and larynx were restored to normal position (Fig. III).

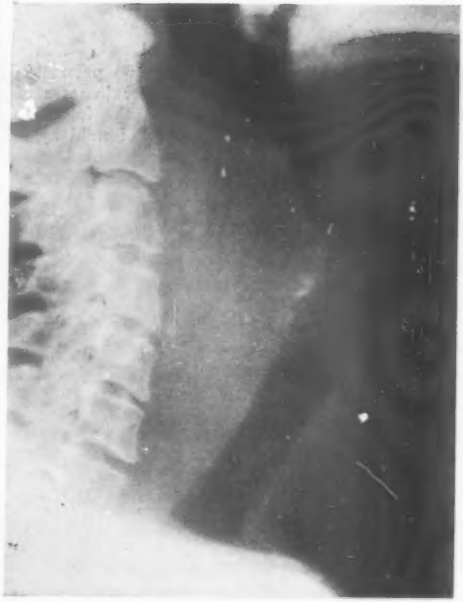


FIG. II. Plain X-ray showing marked forward displacement of the trachea.

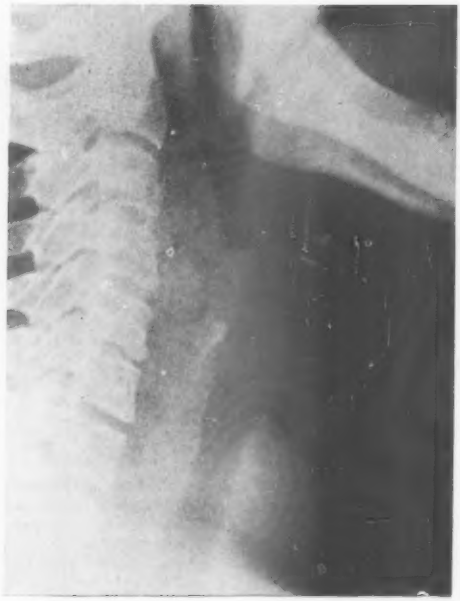


FIG. III. X-ray of trachea following operation.

Pathologist's report.

"The thyroid gland, fixed in 10% formol saline, weighed 280 g. and was shaped like a horseshoe, its lobes hardly distinguishable. Dimensions of those parts which corresponded to the various lobes were: left, 10 x 5 x 4 cm.; right, 11 x 4 x 4 cm.; and middle, 5 x 3 x 3 cm. Consistency was hard and homogenous."

"On section the cut surface was practically of a uniform whiteness with a few slightly darker bands of fibrous tissue apparently subdividing the gland-tissue into miniature lobules." (Fig. IV.)

Microscopically.

"There is gross collagenous proliferation in all areas examined, the strands of collagen being arranged in bands and whorls according to the place of section. Amongst the strands many lymphocytes and plasma cells are scattered, and lymphoid follicular structures frequently appear. This feature, although clearly distinguished, is not excessively prominent."

"There are remnants of thyroid parenchyma in many regions. These take the form either of degenerate acini with or without a minimal colloid content, or of isolated cells, or of cells which appear either to have coalesced to form a homogenous giant-cell structure or to have, as a central core, a minute dot of colloid content. The variation in appearance is probably due to the plane of section of the various aggregations."

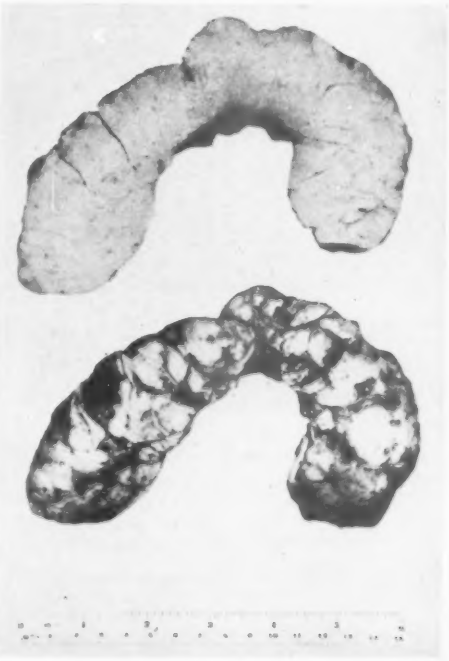


FIG. IV. Photograph of the thyroid gland.

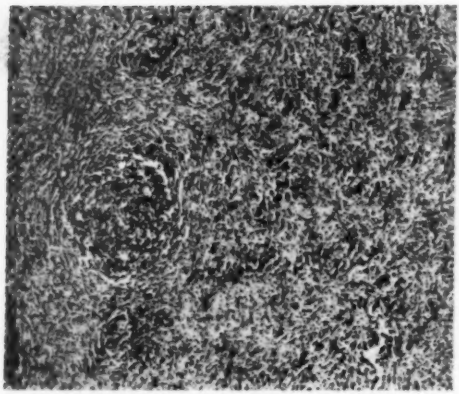


FIG. V. Photomicrograph showing twisted strands of fibrous tissue with one whole lymph nodular structure clearly apparent.

"The homogenous nature of this type of thyroid development, together with the lymphoid aggregations, suggest a diagnosis of Hashimoto's disease. This thyroid, however, has many of the elements of a Reidel's struma in its early stages, and the term Struma lymphomatosa could well be applied to it." (Figs. V and VI.)

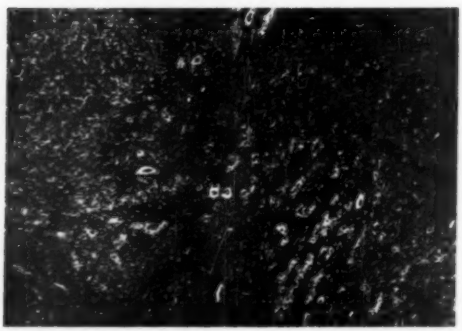


FIG. VI. Photomicrograph showing fibrous tissue at one side and thyroid acini over most of the middle of the field with many small round cells surrounding compressed acinar structures; at the other side is seen part of a lymph nodular structure.

Follow up.

In January, 1949, when seen at Follow-up Clinic, she was very well and had put on two pounds in weight since the operation. A further increase of three pounds in weight occurred in the following month when there was a suggestion of mild hypothyroidism. Extract of thyroid gr. ½ b.d. was prescribed, and this led to improvement in her general well-being, her weight remaining stable.

She complained some weeks later of hot flushes and a feeling of discomfort in the precordium, whereon thyroid extract was suspended.

She has remained well since then and her weight has not altered.

SUMMARY.

(a) A case of atypical lymphadenoid goitre is described.

(b) There was marked forward displacement of the trachea.

(c) The gland encircled completely the lower part of the larynx and upper trachea.

(d) Histological examination showed features of Hashimoto's disease and Reidel's struma.

ACKNOWLEDGEMENTS.

My thanks are due to Mr. R. Hinde for examination of the larynx, to Dr. J. L. Boldero for the radiograph, to Dr. G. A. C. Summers for the pathological report and the photograph, and to Mr. L. Tugwell for the clinical photographs.

REFERENCE.

OLDFIELD, M. C. (1948), *Brit. J. Surg.*, vol. 35, page 325.

JEJUNAL DIVERTICULITIS WITH PERITONITIS.

By T. H. Ackland.

Melbourne.

DIVERTICULOSIS of the small intestine is not such a rare condition as is generally believed, although the occurrence of complications causing symptoms of surgical significance is more uncommon than with diverticulosis of the large intestine.

The following case record reveals that the condition may present itself as a grave surgical emergency. It is an example of the most common complication of jejunal diverticulosis — diverticulitis with peritonitis.

Case History.

A female hospital domestic, aged 46, was admitted to the Royal Melbourne Hospital on 28th September, 1949, with the provisional diagnosis of general peritonitis secondary to a perforated peptic ulcer or acute appendicitis. She stated that for the past fifteen years she had suffered from frequently recurring attacks of colicky abdominal pain. The pain was usually in the umbilical and epigastric regions and was often very severe, causing her to roll about and perspire. The attacks had mostly been of short duration, lasting only about an hour, and were not accompanied by nausea or vomiting.

On the present occasion, however, much more severe pain than usual had begun twenty-four hours before admission to hospital, had persisted without any remission and had become generalized in distribution. She had vomited several times and complained that her abdomen felt "swollen and tender." Her bowel actions had been slightly constipated, but flatus was being passed.

On examination the temperature was 100.2° and the signs of general peritonitis were present. The abdomen was extremely rigid in all areas, although tenderness seemed maximum in the left lower quadrant.

Operation: Under general anaesthesia the abdomen was opened through a right para-umbilical incision and the diagnosis of peritonitis, chiefly confined to the left lower portion of the abdominal cavity, was confirmed. It was found that there were numerous multilocular diverticula of the upper jejunum, several being approximately 3 inches in diameter. One diverticulum was purplish in colour and acutely inflamed with its peritoneal surface shaggy with fibrin. There was, however, no actual gangrene or perforation. The jejunum was normal for a length of 6 inches below the duodeno-jejunal junction and the lower jejunum and ileum contained five much smaller diverticula about ½ inch in diameter, spaced at wide intervals. A loop of jejunum, approximately 3 feet in length, which contained all of the large diverticula and included the inflamed segment, was resected and the continuity of the bowel restored by a side to side anastomosis. Convalescence was uneventful.

Report on the specimen by Dr. E. S. J. King:

"The loop of jejunum after fixation measures 50 cm. in length, and there are a dozen large diverticula projecting from the region of the mesenteric border. Most of these project into the mesentery, distending its leaves, but are more prominent in one side than the other. One diverticulum clearly arises from the bowel at a distance from the mesenteric attachment.

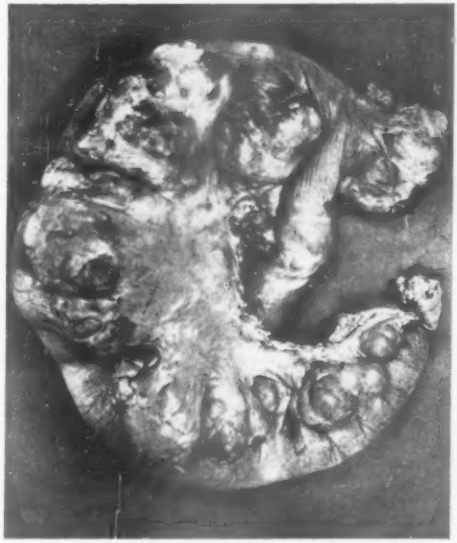


FIG. I: Photograph of the specimen removed at operation.

"Two groups of diverticula (consisting of six placed closely together) show oedema of the wall and peritoneal exudate on their surface.

"The wall of the jejunum is a little thicker than usual, and in size is within normal limits, but the lumen is irregularly dilated, the dilatation corresponding to the region of origin of diverticula. At the site of this dilatation the diameter of the bowel is almost twice that of other parts.

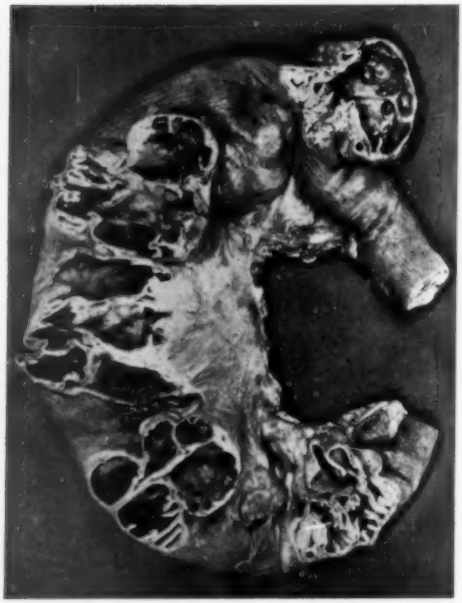


FIG. II: Showing diverticula laid open.

"The diverticula range from 1 cm. to 4 cm. in diameter in the fixed specimen, the majority falling in the upper range. They are irregularly spherical, having thin walls and relatively small openings into the gut. Most of them show secondary pouchings in their walls, this being sufficiently well developed in some to give a multilocular appearance. No foreign body is present in the diverticula.

"Histologically the lining of the diverticula is the same as that of the adjacent intestine. The epithelium covering the villi and the glands is normal in appearance. There is some swelling of the submucous tissues due to accumulation of fluid, and polymorphonuclear wandering cells are present throughout all the coats of the diverticula in the inflamed group. Other diverticula show these changes only in the mucosa, and in the intestine itself they are confined to the submucosa. Since no perforation of the gut was found, the peritonitis was due to spread of infection through the thin walls of the diverticula."

COMMENT.

Many writers have referred to the occurrence of complications in small bowel diverticulosis. These may be inflammatory changes and their sequelae, concretion formation causing intestinal obstruction, haemorrhage, traumatic rupture or volvulus.

In 1945 Walker reviewed 22 cases of jejunal diverticulitis associated with peritonitis, abscess formation, or adhesions. In some instances actual perforation had occurred. Other similar examples have been recorded by Ovens (1943), Gerster (1938), and Moloney and Ward-McQuaid (1949).

It seems probable, as suggested by King (1949) that inflammation of these diverticula is secondary to a jejunitis. However, the strong tendency to perforate is surprising when one considers the fact that the mouths of these diverticula are usually wide, and the contents of the bowel are fluid at this level.

REFERENCES.

GERSTER, J. C. A. (1938), *Ann. Surg.*, vol. 107, page 783.

KING, E. S. J. (1950), *Aust. N.Z. J. Surg.*, vol. 19, page 301.

MOLONEY, G. E., and WARD-MCQUAID, J. N. (1949), *Lancet*, vol. 2, page 418.

OVENS, G. H. C. (1943), *Brit. J. Surg.*, vol. 30, page 239.

WALKER, R. M. (1945), *Brit. J. Surg.*, vol. 32, page 457.

HYDRONEPHROSIS OF AN ECTOPIC KIDNEY RESULTING FROM ACCIDENTAL SURGICAL LIGATION OF THE URETER.

By V. S. HOWARTH.

Gordon Craig Fellow in Urology.

(From the University of Sydney and the Royal Prince Alfred Hospital, Sydney.)

HYDRONEPHROSIS of varying aetiology is commonly associated with renal ectopia, but its occurrence following accidental surgical ligation of the ureter of the ectopic organ has not been recorded in surgical literature and is illustrated by the following case record.

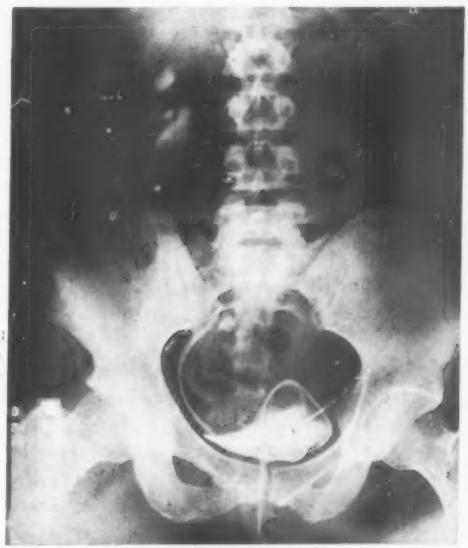


FIG. I. A bilateral retrograde pyelogram. The right pyelogram is normal. The left catheter has met an impassable obstruction just above the spine of the ischium. None of the opaque medium has reached the upper ureter and the injection has all returned to the bladder.

CASE REPORT.

A female aged 44 was first seen in September, 1949. She had been quite well until March, 1949, when she had noticed the onset of an intermittent dull ache low down in the left side of her abdomen where a swelling had also appeared. This was increasing in size, but was not tender on palpation. She also complained of headaches, breathlessness on exertion and precordial pain. There were no symptoms referable to the urinary system. Her past history disclosed that her appendix had been removed in 1944 and that later in the same year total hysterectomy and double salpingo-oophorectomy had been performed.

FIG. II. The anterior aspect of the hydronephrotic sac is shown. The renal pelvis is situated on the anterior surface of an abnormally shaped kidney. The ureter is dilated for 2¾ inches below the uretero-pelvic junction where it becomes constricted at the point of its obstruction in the pelvis by a ligature.

Physical examination disclosed a pale woman whose blood pressure was 210/160 mm., but no clinical abnormalities were detected in her heart and lungs.

Inspection of the patient's abdomen revealed oblique and mid-line scars in the right iliac fossa and hypogost sium. An obvious rounded swelling occupied the left iliac fossa with its upper limit reaching the level of the umbilicus. It appeared to be the size of the full-time foetal head. It was tensely cystic and could be moved from side to side and easily ballotted with one hand on the left flank and the other over the left iliac fossa. It was not tender on palpation. There were no other abnormal physical findings.

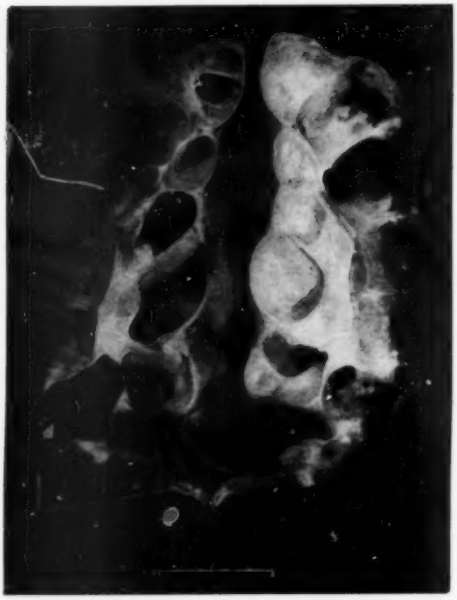


FIG. III. The kidney on section. It contained 500 c.c. of clear non-offensive fluid. Only an extremely thin shell of renal tissue remains in the wall of the hydronephrotic sac. The ureter is dilated to the point of obstruction where it is obliterated.

An intravenous pyelogram demonstrated a normally situated and functioning right kidney, but there was no apparent renal function on the left side. A large soft shadow could be seen in the left iliac fossa extending into the left flank.

Cystoscopic examination disclosed that the bladder was normal and catheters were passed into both ureteric orifices. The right catheter met an obstruction 15 cm. beyond the right ureteric orifice. The left catheter met an impassible obstruction 10 cm. beyond the left ureteric orifice.

A bilateral retrograde pyelogram was obtained which demonstrated a complete obstruction present in the left ureter just above the level of the spine of the ischium. (Fig. I)

A complete obstruction to the left ureter thus being demonstrated, a retroperitoneal approach to the abdominal tumour was made through an oblique low left lumbo-inguinal incision. The tumour was found to be a large hydronephrosis of an ectopic kidney which occupied the left iliac fossa, its upper pole lying just above the crest of the ilium. The distended renal pelvis was situated on the anterior aspect of the organ and the dilated ureter ran over its lower pole for 2½ inches to just below the common iliac vessels where it could be felt to terminate abruptly in a mass of scar tissue. A definite vascular pedicle was not present, but vessels ran to the hydronephrotic sac from the common iliac artery and from the aorta, with a large leash of vessels supplying the upper pole. The left suprarenal gland was not seen at operation. The ureter was ligated and divided at the point of obstruction and, following ligation of the irregular blood supply, the hydronephrotic sac was removed. The abdominal wall was closed in layers and the renal fossa drained.

The patient's convalescence was uneventful and she was then transferred to a physician's care for management of the hypertension which had not been altered by the operation.

The specimen is illustrated in Figs. II and III.

DISCUSSION.

It is not generally recognized that ligation of the ureter produces hydronepbrotic rather than primary renal atrophy, although Hinman (1935) demonstrated experimentally that such was the case. It would appear, also, that in the absence of infection, acute symptoms do not occur following this accident and that the resulting hydronephrosis is of insidious development. In the example recorded the hydronephrosis did not produce pain or swelling until three and a half years later. The writer (1949) records a similar example of hydronephrosis following accidental surgical ligation of the ureter in the base of the broad ligament of the uterus. In this case the patient had been completely free of symptoms for seven years following the accident when the onset of pain necessitated nephrectomy for hydronephrosis. The absence of pain with the onset of the acute ureteral obstruction in both these cases is noteworthy. It would appear

that the development of the hydronephrosis in such cases is very insidious and that pain may only become a feature when the hydronephrotic atrophy is complete. Why this should be so is not apparent.

SUMMARY.

1. An example of accidental surgical ligation of the ureter with hydronephrotic atrophy is a low lumbar ectopic kidney is recorded.

2. The development of hydronephrosis following surgical ligation of the ureter is insidious.

3. Pain may not be a clinical feature until hydronephrotic atrophy is complete, and in the case recorded, three and a half years passed without symptoms or signs.

4. The presence of infection would appear to determine the onset of acute symptoms following surgical ligation of the ureter.

ACKNOWLEDGEMENTS.

I am indebted to Mr. M. S. S. Earlam, of the Department of Urology, the Royal Prince Alfred Hospital of Sydney, for permission to record this case and to the Department of Medical Artistry, the University of Sydney, for the photography.

REFERENCES.

HINMAN, F. (1935), "Principles and Practice of Urology." Philadelphia: W. B. Saunders Company, page 472.

HOWARTH, V. S. (1949), *Med. J. Aust.*, vol. 2, page 678.

LAIDLEY, J. W. S., and HOWARTH, V. S. (1949), *Aust. N.Z. J. Surg.*, vol. 19, page 40.

THOMAS, G. L., and BARTON, J. C. (1936), *J. Amr. Med. Assoc.*, vol. 106, page 197.

THOMPSON, G. J., and PACE, J. M. (1937), *Surg. Gynec. Obstet.*, vol. 64, page 935.

AN UNUSUAL CASE OF INTUSSUSCEPTION.

By C. M. MAXWELL.

Sydney.

THIS report concerns a case of intussusception following partial gastrectomy with entero-anastomosis, the intussusception commencing in the long afferent loop traversing the entero-anastomosis and almost reaching the stomach in the efferent loop. A correct diagnosis was not made but in retrospect it seems that, if all the clinical findings had been correlated, this would have been possible.

Mrs. E.B., aged 51, was admitted to hospital on 25th November, 1949, complaining of severe colicky pain in the abdomen of about forty hours duration. Her bowels had not been opened in the previous fifty hours and she had been vomiting intermittently for two days. The vomitus was not excessive in amount. It first consisted of food in which some paraffin was noted, but later it became blood-stained.

In 1922 the patient had had an appendicectomy. There was probably an appendiceal abscess as para-rectal and grid-iron incisions had been made and the abdomen was drained for two weeks. In 1945 a partial gastrectomy was performed for ulcer. The patient was quite well for one year following her gastrectomy, except that she did not gain weight. After this period she commenced to get intermittent abdominal pains of a colicky type, generalised in distribution, but felt particularly in the mid-abdomen and groins. They were usually relieved by paraffin and recumbency. The patient has always "had a high blood pressure."

On Examination: The patient, who was a thin woman, looked sick, and was in obvious distress. Her temperature was 97° — pulse 100 — and blood pressure 180/110. There was a large, tender U shaped mass in the lower abdomen to the left of the umbilicus. Gastric aspiration produced about 6 ozs. of fluid stained with bright blood. A second enema resulted in a clear return. A diagnosis of intestinal obstruction was made, an intravenous serum transfusion commenced and the patient prepared for operation.

Operation: Under gas-oxygen and ether anaesthesia, the abdomen was opened by a left lower paramedian incision placed directly over the mass, which was found to be an intussusception. An anterior long-loop partial gastrectomy had been performed with an entero-anastomosis between afferent and efferent loops of jejunum. The intussusception had commenced in the long afferent loop, below the entero-anastomosis, its apex had traversed the entero-anastomosis and ascended the efferent loop in an anti-peristaltic direction almost reaching the gastro-jejunostomy. Reduction was found impossible by ordinary methods, but was finally achieved by loosening the neck and opening the small bowel, when, by combination of pressure at the apex, plus loosening and traction at the neck, it was finally accomplished. The mucosa of the intussuscepted loop was black and had a slight odour. However, the peritoneal coat was glistening and good pulsation was seen and felt in the mesenteric blood supply to the part, so it was considered safest to return the bowel without resection. The opening into the ileum was sutured transversely. Gastric suction and intravenous therapy were continued for several days, and the patient made an uninterrupted recovery. The bowels opened naturally on the fifth day and the patient was up on the tenth day.

DISCUSSION.

Plain X-rays of the abdomen were not taken. They would have localised the obstruction to the upper jejunum. It was not known that an entero-anastomosis had been done with the partial gastrectomy, but as retrograde intussusception following gastrectomy has been frequently reported, this, combined with the picture of intestinal obstruction, blood-stained vomitus, and a well-marked mass, should have given a clue to the correct diagnosis. The misleading factor was that the mass was situated below the umbilicus in the left iliac fossa.

Books Reviewed.

PHOTO-RADIOGRAPHY IN SEARCH OF TUBERCULOSIS.
Williams & Wilkins Co., 1949. 6½" x 10", xi plus 297 pp., 274 figures. Price: 53s. 9d.
By DAVID W. ZACKS, M.D. Baltimore, U.S.A.: The

In this book Dr. Zacks discusses the complete organization of a campaign for case-finding in pulmonary tuberculosis, from the initial planning to the reading of films and the disposal of persons in whom an abnormal chest is discovered. The interpretation of miniature photoradiograms is vastly different from that of 17 x 14 inch films and the author believes that even experienced radiologists and chest physicians will require to examine at least 1,000 normal and abnormal photoradiograms before they are expert in this work.

The review of large series of persons examined in this way shows that approximately 13 out of every 1,000 show radiological evidence of active or inactive pulmonary tuberculosis and a significant number of non-tuberculosis chest abnormalities requiring treatment is picked up. Mass chest radiography or photoradiography is recognised as the most important method for case-finding in pulmonary tuberculosis and must form the basis of any campaign for the control of this disease. Dr. Zacks has devoted twenty years of his life to the control of tuberculosis and answers many of the problems which must arise in any community when a tuberculosis case-finding campaign is projected.

A survey of this type is a very vast undertaking, and although a single X-ray unit, working at high pressure, can make up to 80 exposures in an hour, in actual working it is found that 50,000 to 60,000 examinations on 4 x 5 inch single-cut film or 80,000 on 70 mm. roll film is a reasonable yearly output for one X-ray unit. The relative merits of 4 x 5 inch single-cut film and 70 mm. roll film are compared, but no mention is made of 35 mm. roll film, which appears to have been largely discarded in the United States. Although the immediate aim of mass chest radiology is to examine as many chests as possible, this author believes that the ultimate aim is the establishment of chest X-ray services which will be available on a permanent basis for all persons either through private physicians, Health Departments or co-operating community health agencies.

The book is well produced on good paper and profusely illustrated, and the atlas of chest photoradiograms which occupies more than half the book should prove of great help in avoiding errors of interpretation. Under-reading of films results in the overlooking of significant lesions, and over-reading adds greatly to cost and labour in that many chests will be unnecessarily re-taken on 17 x 14 inch photoradiograms films. Some errors will always occur, but a high degree of accuracy in reading photoradiograms is possible.

All who are concerned with public health work or are interested in the control of tuberculosis should read this book, which is a real contribution to the literature of this subject.

FRACTURES AND DISLOCATIONS IN GENERAL PRACTICE.
By JOHN P. HOSFORD, M.S.(Lond.), F.R.C.S. Second Edition, revised by W. D. Coltart, M.B., B.S.(Lond.), F.R.C.S. London, Eng.: H. K. Lewis & Co. Ltd., 1949. 5½" x 8½", x plus 290 pp., 87 illustrations. Price: 21s. net.

This volume is one of the General Practice series. It first appeared in 1939 and was written by a general surgeon who was then interested in fractures. This, the second edition, has been revised by an orthopaedic surgeon, but the scope of the book has not altered appreciably. It gives a sound, elementary introduction to the subject without the details that are found in a larger textbook.

The author has given an excellent account of the principles underlying the treatment of all the common fractures. In order to cover the subject in such a compact volume, he has often had to describe one method for a particular fracture and omit other forms of management which are also widely used. He gives the typical British conservative approach to the subject. Although this may be wise especially in a book written primarily for those in general practice, he has been over-cautious in his attempt to bring the edition up to date. For example, the reader will still find a plaster spica described as a worthwhile alternative to a Smith Petersen pin in the treatment of uncomplicated fractured neck of femur. Internal fixation is not mentioned in the management of the difficult Monteggia type of fracture of the ulna, and it is described as almost a last resort in treating the common, unstable, oblique fractures of the lower third of the tibia. One feels that the management of such problems as these has altered so much in the last ten years with the introduction of penicillin and vitallium that they should now be discussed in a different perspective.

This book can be confidently recommended to final-year students and those in general practice who wish to understand the general principles underlying the management of the common fractures. For those who are called on to treat numbers of fractures, one of the larger textbooks will have to be consulted.

A TEXTBOOK OF SURGICAL PATHOLOGY.
By C. F. W. ILLINGWORTH, C.B.E., M.D., Ch.M., F.R.C.S.(Ed.), and BRUCE M. DICK, M.B., F.R.C.S. (Ed.). Sixth Edition. London: J. & A. Churchill Ltd., 1949. 9" x 6", viii plus 726 pp., 317 illustrations. Price: 45s. net.

The sixth edition of this book is essentially similar to the previous editions. The appearance of six editions (with two re-printings) indicates a demand for works of this type and, indeed, for this particular one.

Beginning, therefore, with the premise that this book is a satisfactory example of its kind, we may examine the genus a little more closely. What is surgical pathology? The scope of the surgeon is becoming so broad that it is doubtful if there is any part of the study of disease that can be said to lie quite outside his purview; that is, any part

that is not surgical pathology. It would be preferable to refer to pathology for surgeons. But has not the time come when an account of pathology, or, indeed, any subject, should be written by those thoroughly acquainted with it? The widening of the surgeon's horizon has been shown by the addition, through the various editions, of regions and organs such as lung and pleura, some ductless glands and, in this volume, the pericardium, heart and great vessels.

This most recently introduced chapter indicates the inevitable shortcomings of this kind of book. It is a short, concise and therefore thoroughly inadequate and, indeed, useless statement — of some possible value to a junior student cramming for an examination, but of no use to the "senior students of surgery," for whom it is said to be written. It would be much better for such students to spend a little time on the appropriate section of a monograph or special textbook. This may be said of many of the chapters. This, however, is a general criticism of this kind of textbook rather than a special one of this particular volume.

As far as special objections are concerned, the time has long passed when statements such as those in the table on page 670, that stratified epithelium is necessarily ectodermal and the like, can be condoned. This is not pathology — not even surgical pathology.

At the same time, for the purpose for which it is presumably used, this book is a good one of its kind. It is well produced, the text is clear and most of the illustrations are adequate.

A MANUAL OF THE PENICILLIA.

By KENNETH B. RAPER and CHARLES THOM, with the technical assistance and illustrations by Dorothy I. Fennel. Baltimore, U.S.A.: The Williams & Wilkins Co., 1949. 9" x 5¾", ix plus 875 pp., 172 figs. Price: £6 9s.

Mycologists and others interested in the Penicillia have been awaiting an up-to-date taxonomic treatment of this ubiquitous and difficult genus.

The advent of antibiotics into the field of medicine quickened our interest, for many species of Penicillium yield these as metabolic products, and there is also an ever-widening use of these moulds in the economic field. Thom's earlier work has been the standard reference book, but even the most experienced mycologist found extraordinary difficulties when attempting to name isolates of this genus. The new manual which incorporates much of the earlier work offers more encouragement to those who seek to know the forms they are handling. It contains a wealth of information about the forms grouped together in the genus and many of the descriptions are accompanied by photographs and line drawings of excellent standard. The concept of series is emphasized — that is, the recognition of groups of strains of fairly constant morphology and usually with related biochemical activities and within these broader groupings the recognized species are placed. As Raper says, "The manual is designed primarily as a means for identifying the Penicillia which may be encountered in the laboratory." The material contained in this book certainly does help towards this end. There are, however, still difficulties when one uses the manual from this angle, as reference to the Key to the Monoverticillata will show. The prime choice in this key still stresses colony texture (always difficult and variable). If the choice be, colonies velvety or nearly so, one should not expect to find under this division further in the key "colonies deeply lanose." As this key leads one to the appropriate series, it still offers many pitfalls even to the most experienced user.

We owe a debt of gratitude to those who have gathered together such a vast amount of information and presented it in such an attractive form. It is a book that must be available to all mycological workers in whatever field their interest lies.

Books Received.

HANDBOOK OF SURGICAL UROLOGY FOR INTERNES, HOSPITAL CORPSMEN AND NURSES.

By NELSE F. OCKERBLAD, M.D., F.A.C.S. Baltimore, U.S.A.: The Williams & Wilkins Co., 1949. 7½" x 5¼", vii plus 189 pp., 52 figs. Price: £1 12s. 3d.
(Sent by Angus & Robertson Ltd., Sydney.)

VITAMINOLOGY—The Chemistry and Function of the Vitamins.

By WALTER H. EDDY, Ph.D. Baltimore, U.S.A.: The Williams & Wilkins Co., 1949. 9" x 5¾", 37 figs., 60 tables. Price: £3 4s. 6d.
(Sent by Angus & Robertson Ltd., Sydney.)

HANDBOOK OF MEDICAL MANAGEMENT.

By MILTON CHATTON, A.B., M.D., SHELDON MARGEN, A.B., M.D., and HENRY D. BRAINERD, A.B., M.D. First Edition. California, U.S.A.: University Medical Publishers, 1949. 7" x 4", 476 pp., numerous tables. Price: $3.

LES TUMEURS MALIGNES DES VOIES AERO-DIGESTIVES SUPERIEURES.

By J. DUCUING and L. DUCUING. Paris: Masson et Cie, 1949. 9¼" x 6", 582 pp., 170 figs. Price: 2000 fr.

PETITE CHIRURGIE ET TECHNIQUE MÉDICALE COURANTE.

By G. ROUX. Third Edition. Paris: Masson et Cie, 1949. 9½" x 6¼", 642 pp., 385 figs. Price: 1750 fr.

STERN'S APPLIED DIETETICS: The planning and teaching of Normal and Therapeutic Diets.

Revised by HELEN ROSENTHAL, B.S., PEARL C. BAKER, B.S., and WILMA A. McVEY, M.D. Third Edition. Baltimore, U.S.A.: The Williams & Wilkins Co., 1949. 10" x 6½", xix plus 293 pp., limited illustrations, 62 tables. Price: 53s. 9d.
(Sent by Angus & Robertson Ltd., Sydney.)

BLAKISTON'S NEW GOULD MEDICAL DICTIONARY.

Edited by HAROLD WELLINGTON JONES, M.D., NORMAND L. HOERR, M.D., ARTHUR OSOL, Ph.D., with the co-operation of an Editorial Board and 80 Contributors. First Edition. Philadelphia-Toronto: The Blakiston Co., 1949. 9¼" x 6½", xxviii plus 1294 pp., 252 illustrations on 45 plates, 129 in colour. Price: £4 4s.

STEDMAN'S MEDICAL DICTIONARY.

Edited by NORMAN BURKE TAYLOR, M.D., F.R.S.C., F.R.C.S.(Edin.), F.R.C.P.(Cant.), M.R.C.S.(Lond.) in collaboration with ALLEN ELLSWORTH TAYLOR, D.S.O., M.A. Seventeenth Revised Edition. Baltimore, U.S.A.: The Williams & Wilkins Co., 1949. 6" x 9", xliv plus 1361 pp., numerous illustrations. Price: £4 11s. 6d.
(Sent by Angus & Robertson Ltd., Sydney.)

EPIDEMIOLOGY IN COUNTRY PRACTICE.

By WILLIAM NORMAN PICKLES, M.D.(Lond.), with a preface by Major Greenwood, F.R.S., D.Sc., F.R.C.P. London, Eng.: John Wright & Sons Ltd., re-issued 1949. 5½" x 8½", viii plus 122 pp., 3 photographs, 2 figs., 11 charts. Price: 10s. 6d.